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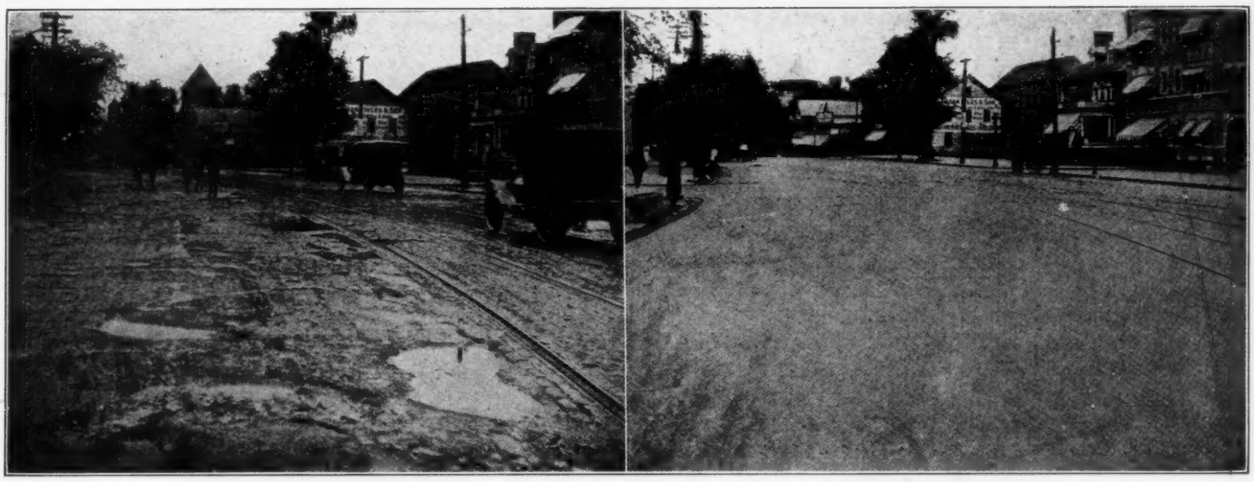

BEFORE SURFACING
Old Concrete Pavement, Massachusetts Avenue, Cambridge, Mass., before surfacing with Bitulithic, August, 1914.

AFTER SURFACING
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Municipal Engineering

Design, Construction, Operation and Maintenance of all Public Works

Vol. LIV. JANUARY, 1918. No. 1.

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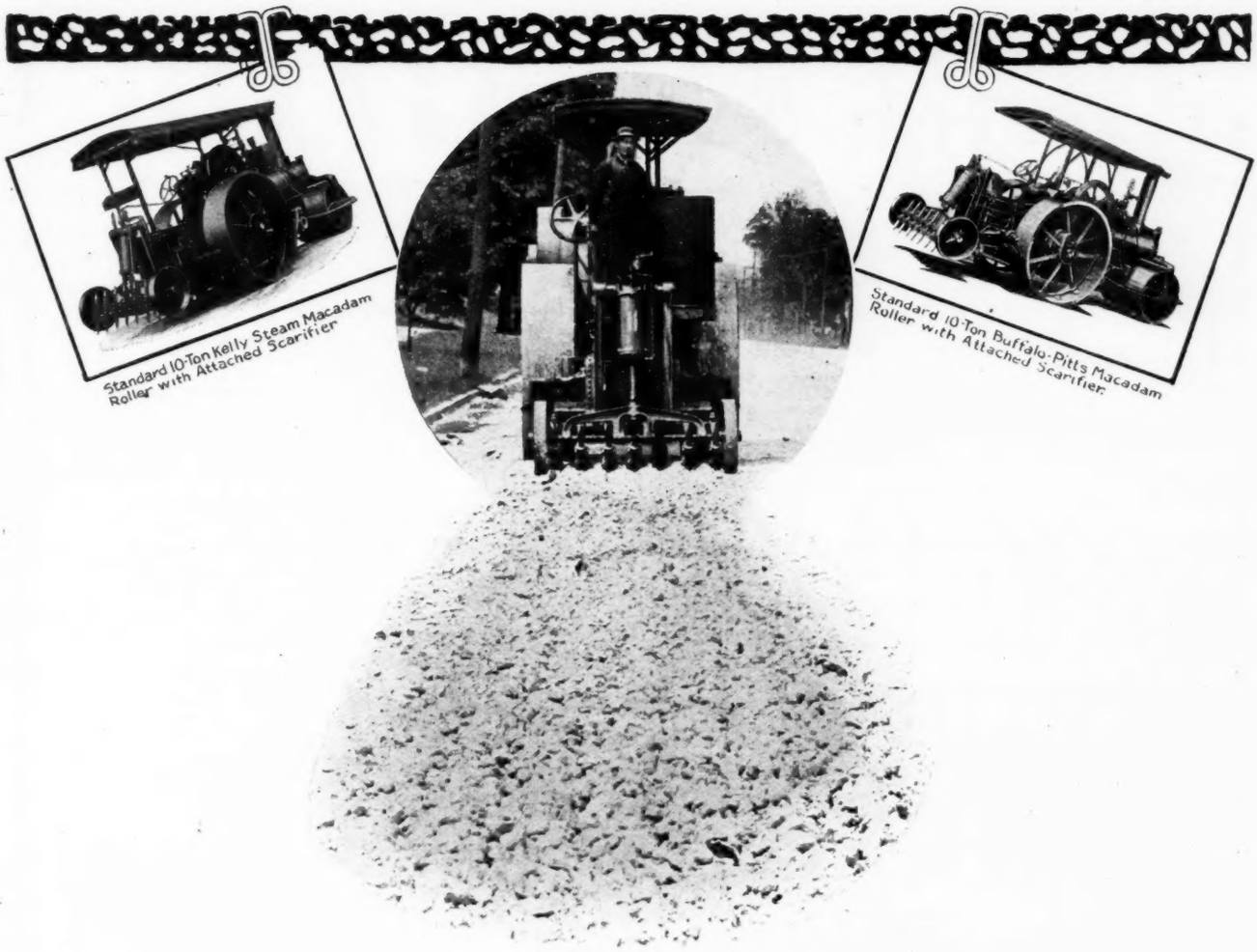
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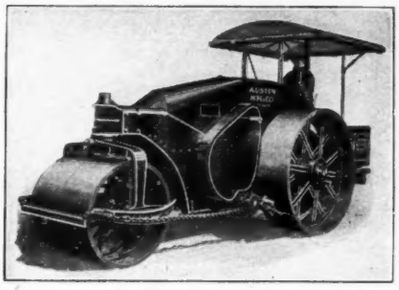

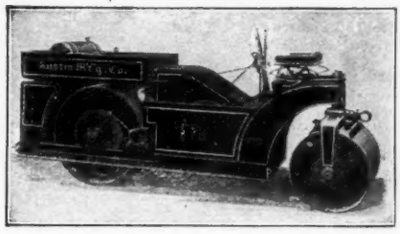

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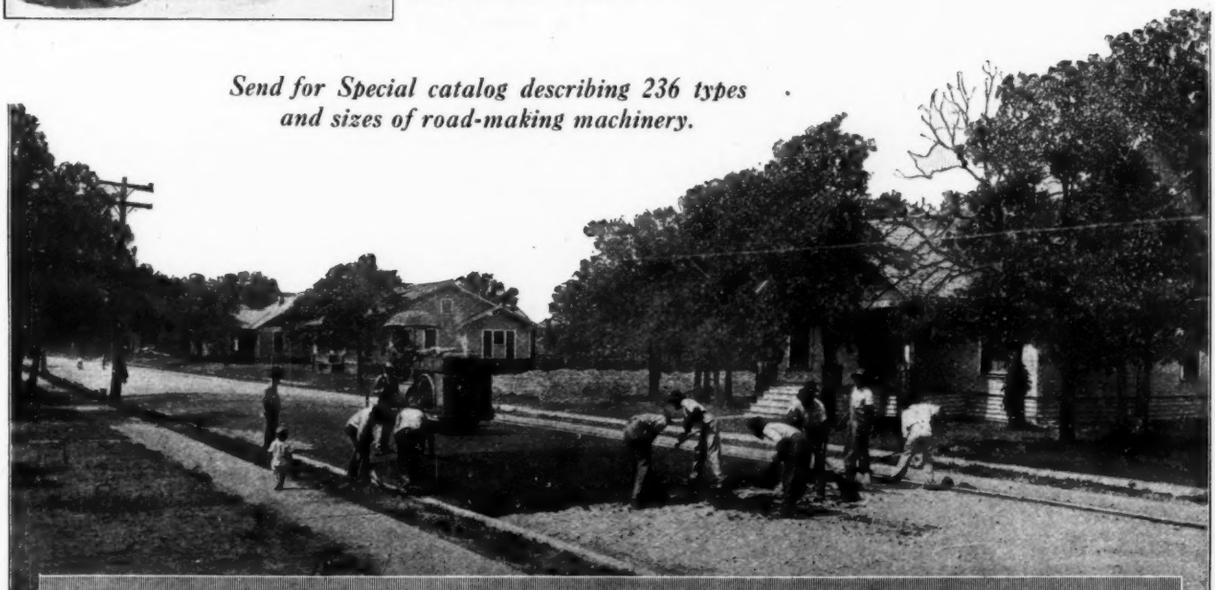

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STANOLIND PAVING ASPHALT.

Stanolind Paving Asphalt

produced under a new and patented process, furnished in all consistencies suitable for

SHEET ASPHALT
ASPHALTIC MACADAM

ASPHALTIC CONCRETE
Also Seal Coats for Water Bonded Roads

OTHER ROAD PRODUCTS

Standard Macadam Asphalt Binder B.
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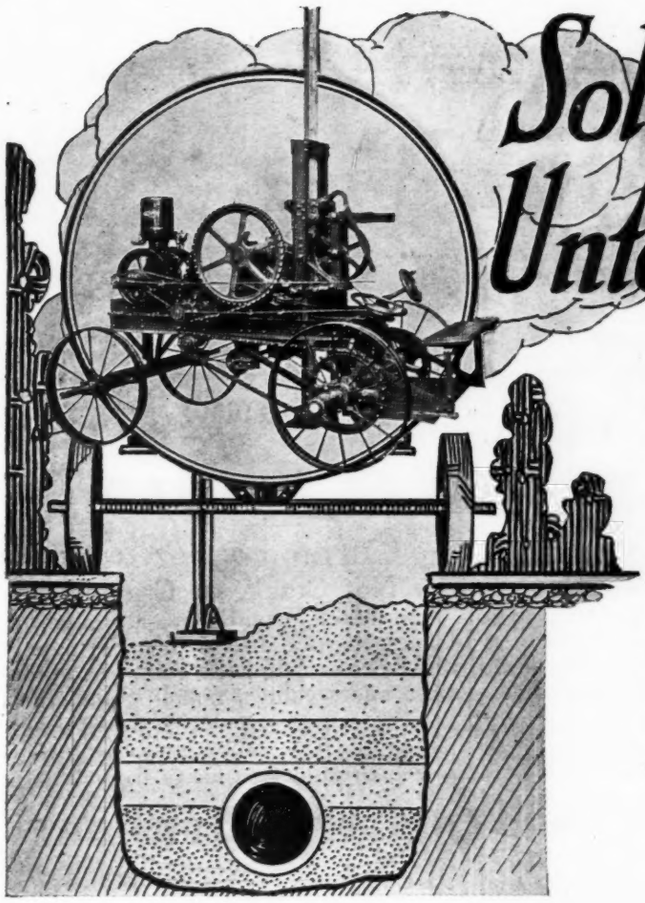
IF we desire to avoid insult, we must be able to repel it; if we desire to secure peace, one of the most powerful instruments of our rising prosperity, it must be known that we are at all times *ready* for war.

—*George Washington.*



Solid as the Untouched Street

Firm! Packed to Even Density!!
Not a fraction of an inch of "settle" is left in the Solid-hammered layers of the trench tamped with a "P & H" Power Traction Tamper. ***Surplus power!*** To compact even the toughest, most resisting clays!! That's why contractors feel *safe* in paving over ***freshly tamped*** trenches when a "P & H" is on the job.

Up to ***Full Height!*** Down with its ***150-Pound*** Blow!! And 42 sledge hammer hits every minute. There are no slipshod, Half Blows with the "P & H." Every ***foot*** of trench it hammers is ***permanent! Uniform!!***

Jar of wheels! ***Pound*** of trucks!! ***Settle*** of rains!! And a lot of other earth packers are Beat in the ***Bang*** of the "P & H" ram. That's why the ***heaviest*** of traffic won't Settle and Crack the paving over a "P & H" tamped trench!

Get details about the "P & H" Power Traction Tamper. You ought to be acquainted with this "slam-banger."

Pawling & Harnischfeger Co.
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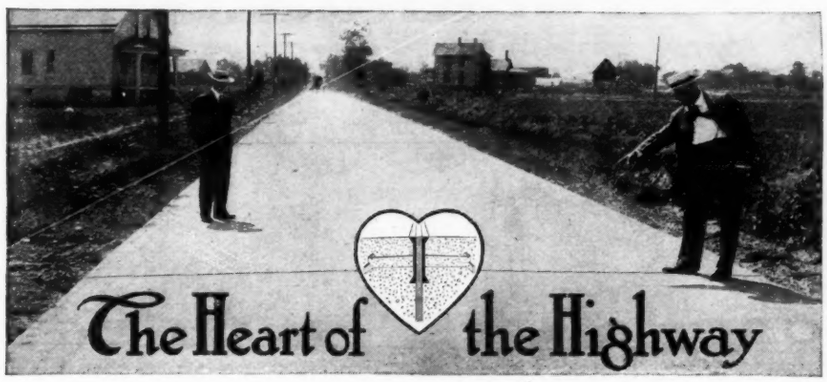

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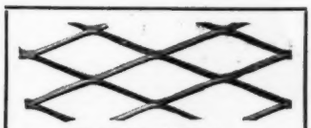
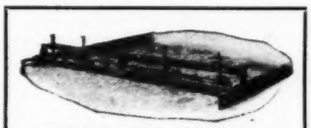
Kahn Armor Plates

THE joint in the concrete pavement determines its success. Protect the joint with the bevel-edged Kahn Armor Plates and you are sure the concrete cannot break down or chip away. Install the plates with our improved installing device and accuracy is assured. Reinforce the pavement with Kahn Mesh to prevent cracks in the roadway. If there are concrete curbs, reinforce and protect them with Kahn Curb Bars.


Kahn Road Mesh


Kahn Installing Device

Kahn Road Book—a highway handbook—free on request. Write for our literature.

TRUSSED CONCRETE STEEL CO.
Highway Department **Youngstown, Ohio**
Representatives in Principal Cities.

Kahn Curb Bar

New Pavement Old Curbing

Waterloo Road, Cleveland, had to be repaved in 1916, but the "Buckeye Berea" Curbing, laid with the original pavement thirteen years ago, was as good as when originally set. (Above photo taken August, 1917.)

"BUCKEYE BEREA"

Natural Sandstone Curbing *outlasts pavements* because it Does Not Crack, or Crumble, or Disintegrate. It is not "man-mixed," neither is it an imitation. It is the *selected best* of nature's rock itself. It's Permanent quality—its Freedom from flaws and upkeep costs—its ability to *resist* the action of time and weather, make it the *Ideal* Curbing.

To make sure you are getting the Best, *specify* "Buckeye Berea Natural Sandstone Curbing as quarried by the Ohio Quarries Co."

When you are laying a Permanent Pavement, why not also lay a Permanent Curbing? That's "Buckeye Berea" Natural Sandstone Curbing!!

THE OHIO QUARRIES COMPANY

CLEVELAND

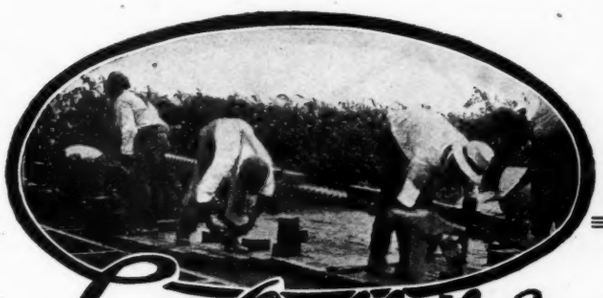
YOUR GUARD AGAINST FREEZING TROUBLES

No matter how cold the weather! Your meters are protected against freezing *if* they're housed in **Ford Meter Boxes!** Scores of cities (with hundreds of outside installations each) report that **Ford Meter Boxes** are ample *insurance against freezing* in the coldest weather.

Let us tell you about the New Ford Meter Holding Yoke and Expansion Connection in which an angle stop valve is placed in either one or both ends, thus doing away with the necessity for the ordinary curb cock and box. These yokes with double valve arrangements are recommended for meter installations where it is desirable to shut off back water from property in case meter is temporarily removed.

Exclusive manufacturers of "Ford" Systems of Meter Settings, Testers and Accessories.

The FORD METER BOX Co.
WABASH, INDIANA, U.S.A.



Laid Double the Yardage with 3/4 the Labor

Louis Schauder
Contractor
Tiffin Ohio

"Four 12-foot sections of Mathews Gravity Brick Carriers," says Mr. Schauder, "reduced our pay-roll by six men.

"Twenty-five men were formerly required to lay 15,000 to 30,000 yards per 8-hour day, but we now make the same record (sometimes 33,000) with but nineteen men.

"Mathews Gravity Brick Carriers speed up the job because the setters always have just the right number of brick at hand. The brick travel by their own weight. There is no chipping or damage to the brick."

Mathews Gravity Brick Carriers (8 inches in width) are made in 8, 10, 12, 14 and 16-foot sections—with or without caster supports and apron. Let us send you the pay-roll savings of scores of leading paving contractors.

Send for Bulletin No. E-4.

MATHEWS GRAVITY CARRIER CO.
ELLWOOD CITY, PA.

Chausse Surface Heaters

CHAUSSE "Pluto" Surface Heaters will heat 36 sq. ft. of sheet asphalt surface to a proper consistency for handling in from 5 to 7 minutes. The first cost of the **"Pluto"** is small, and so is its operating cost. One man operates it and the fuel required is 6 gals. of kerosene per hour. A special type is built for working close to car tracks.

This is the machine that saved the City of Detroit $20,000 on asphalt street patching. (See *Municipal Engineering,* November, 1917, page 185.)

We have a full line of Surface heaters, tool furnaces, babbit burners, torches and other special kerosene vapor burners

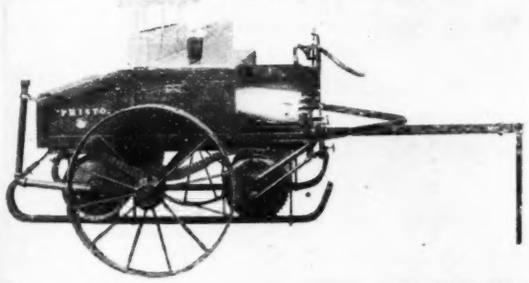
Write for Illustrated Circular

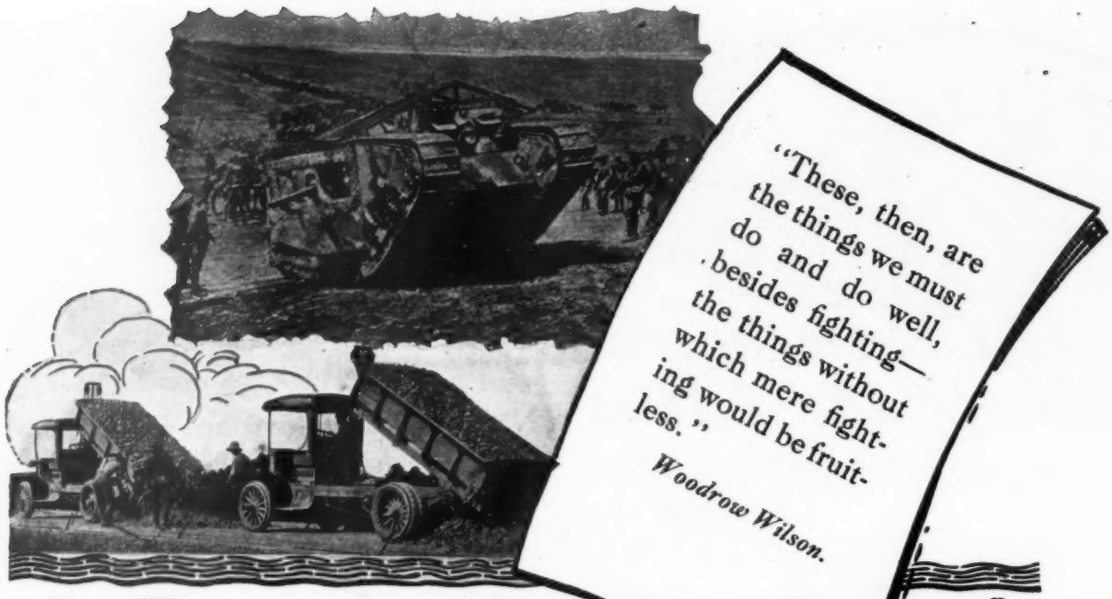
ALGER SUPPLY COMPANY

Peoples Gas Building **CHICAGO, ILL.**

PHISTO TOOL HEATER

On a consumption of 3 gals. of kerosene per hour, the **"Phisto"** Tool Furnace will keep fourteen tools, three pails of binder and three shovel scoops constantly hot. It gives a cleaner flame of more intense heat than can be produced by any wood burning furnace and does away with the trucking of wood and ashes.




"These, then, are the things we must do and do well, besides fighting—the things without which mere fighting would be fruitless."
Woodrow Wilson.

A Patriotic Service for Engineers and Contractors

EFFICIENCY

Must be our War Time Watchword!

We who are left behind must work with a "swifter-than-peace-time" speed. Extra effort must be made by the *fewer* men who must carry *greater* loads.

For it is essential that the fewer directing minds, and the fewer working hands must (in the end) show vastly *greater* results.

Road work must be forced forward! Sewer construction must be speeded! Water works extension must be crowded forward. All must come through to the finish in *better* than record time.

Here and now new tasks must be begun, and present work must be carried speedily to completion.

Certain it is that the work will be prosecuted with the same unselfish devotion that marks the fighting regiments. It is for *you* to join the ranks of the men who are to help make victory fruitful.

So we say: *Plan* big work! *Think* big work!! *Talk* big work. Put *your* shoulder to the wheel and help to "do well the things without which mere fighting would be fruitless."

Municipal Engineering

Solved

—with absolute accuracy in 2 min. 25 sec.

Find percentage of each item manufactured and cost per lb. of various items contributing to the expense.

No. 1	187,515 lbs.	.154149
No. 2	246,735 lbs.	.202831
No. 3	565,467 lbs.	.464848
No. 4	216,738 lbs.	.178172
	1,216,455 lbs.	1.000000

		Cost per Lb.
Labor	$148,970.00	.122462
Fuel	2,150.50	.001768
Power	750.00	.000617
Light	255.45	.000210
Heat	360.50	.000296
Rent	525.00	.000432
Office Ex.	25,350.50	.020839
Taxes	3,250.50	.002672
Overhead	12,360.00	.010161
	$193,972.45	.159457

1 divided by 1,216,455= .00000082206082.

The New Pony Marchant Calculator

Should be as close on companion in both engineering and industrial service for absolute computations, as is the slide rule for approximate calculations.

This little calculating machine—it weighs just 12 lbs. —is actually human in its range and capacity, ***far more than human in speed and accuracy.*** It multiplies, divides, adds, subtracts, prorates, figures per cents, does fractions in a manner that will surprise and delight you.

It is mechanically perfect, easy operated, of proven merit. With it available, to continue to figure by hand or "in your head," is deliberately to court trouble through mistakes and to waste time. Send for our special Bulletin for Engineers and in Industrial service.

Marchant Calculating Machine Co., Emeryville, Oakland, Cal.

Chicago Branch Office: 359 Railway Exchange Building.

"PIONEER"

The Sterling of Bitumens

The temperature in Winnipeg, Canada, is a rigorous test of Sheet Asphalt Paving. It ranges from 40 below zero to 96 above. **PIONEER Cement Asphalt** was laid in Winnipeg more than six years ago, and Mr. J. W. Astley, former engineer of Construction, says, Pioneer pavements show no waving even now.

Our products are of the Highest Quality. They are prepared by experts and will stand the most severe tests and are backed for satisfactory service.

We invite investigation.

THE PIONEER ASPHALT COMPANY

Producers of Highest Quality Bituminous Asphalt

LAWRENCEVILLE, ILL.

SPECIFY WARREN

Cast Iron Pipe

For Water, Gas, Culverts, Sewers

We specialize in Bell and Spigot and Flanged Special Castings. Also flexible Joint Pipe, Cylinders, Tubes, Milled and Plain Ends—High Pressure Fire Service Pipes.

Warren Foundry & Machine Co.

Works: Phillipsburg, N. J.

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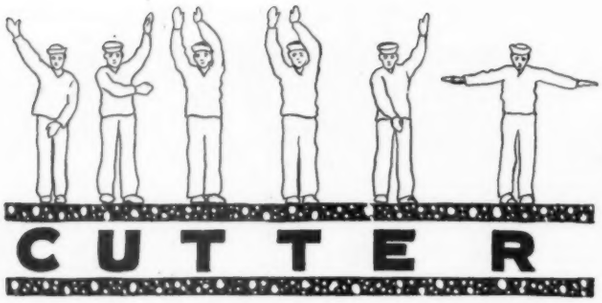
201 Devonshire St., Boston, Mass.

"Quality and Service Guaranteed"



The Signal that's heeded! Cutter Traffic Signal Posts are *real* warnings!!

Through rain or snow, that ***Ruby Red*** glow carries a warning to night joy-riders! By day, the ***Ruby Globe*** is distinctly seen above crowds and vehicles. It's a "Safety First" Signal that all obey.

Cutter Traffic Signal Posts are "Always on the Job"

Our Booklet gives details—write for it.

GEORGE CUTTER COMPANY
SOUTH BEND, IND.
Chicago Detroit New York
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An "Armco Iron Culvert being placed under the California" State Highway near Fresno, California.

When War makes Labor Scarce

it is a satisfaction to know that unskilled men can install

"ARMCO" IRON CORRUGATED CULVERTS

quickly and efficiently. They are shipped without delay, hauled easily and placed quickly, and will last a generation.

Their unfailing durability is their chief recommendation. They are made of "Armco" Iron—the purest and most rust-resisting iron that can be used.

AMERICAN ARMCO IRON
Resists Rust

For full information on Rust-Resisting "Armco" Iron Culverts, Flumes, Siphons, Sheets, Roofing and Formed Products, write

Armco Iron Culvert & Flume Mfrs. Association
CINCINNATI, OHIO.

"WHY"

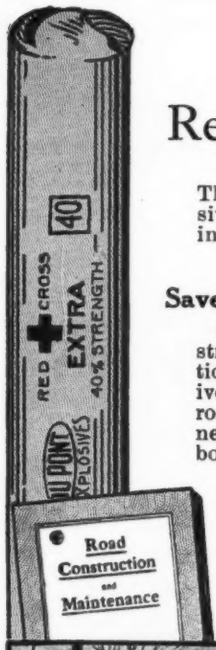
Genuine Berea Sandstone Curbing

IS SO EXTENSIVELY USED

BECAUSE:

It is *Nature's* formation
It is durable—lasts generations
It adds beauty to your streets
It does not disintegrate nor decay
It defies the elements
It has character
It is *dependable*
It is sold at a reasonable price

THE CLEVELAND STONE CO.
PRODUCERS
MAIN OFFICES:
Leader-News Building CLEVELAND, OHIO.
WESTERN OFFICES:
522 Marquette Building CHICAGO, ILL.



DU PONT

Red Cross Explosives

FOR ROAD IMPROVEMENTS

The combined use of Red Cross Explosives and modern road machinery will, in many cases,

Hasten Construction, Save Labor and Lower Cost of Work

Our FREE BOOKLET "Road Construction and Maintenance" gives practical data how to use explosives exclusively, or in combination with modern road building machinery for building new and improving old roads. The book should be read by every engineer, road-builder and highway official. Write for "ROAD CONSTRUCTION and MAINTENANCE" Booklet.

E. I. du Pont de Nemours & Co.
Powder Makers Since 1802
WILMINGTON, DELAWARE

KOEHRING
MIXERS

"Every Batch—Quick! *Thorough!!*

"And it goes fast to the ***right*** spot," says the Hunt-Forbes Construction Co., Contractors, Ashland, Ky.

"That's what we ***always*** get from our No. 16 **Koehring,** 1000 to 1200 square yards of graveled slag concrete per 8-hour day, and we've been doing it for three years.

"**Koehrings** ***always*** run smoothly! That's way they handle their work ***easily!*** That's why our No. 6 and No. 16 **Koehrings** are still on the job.

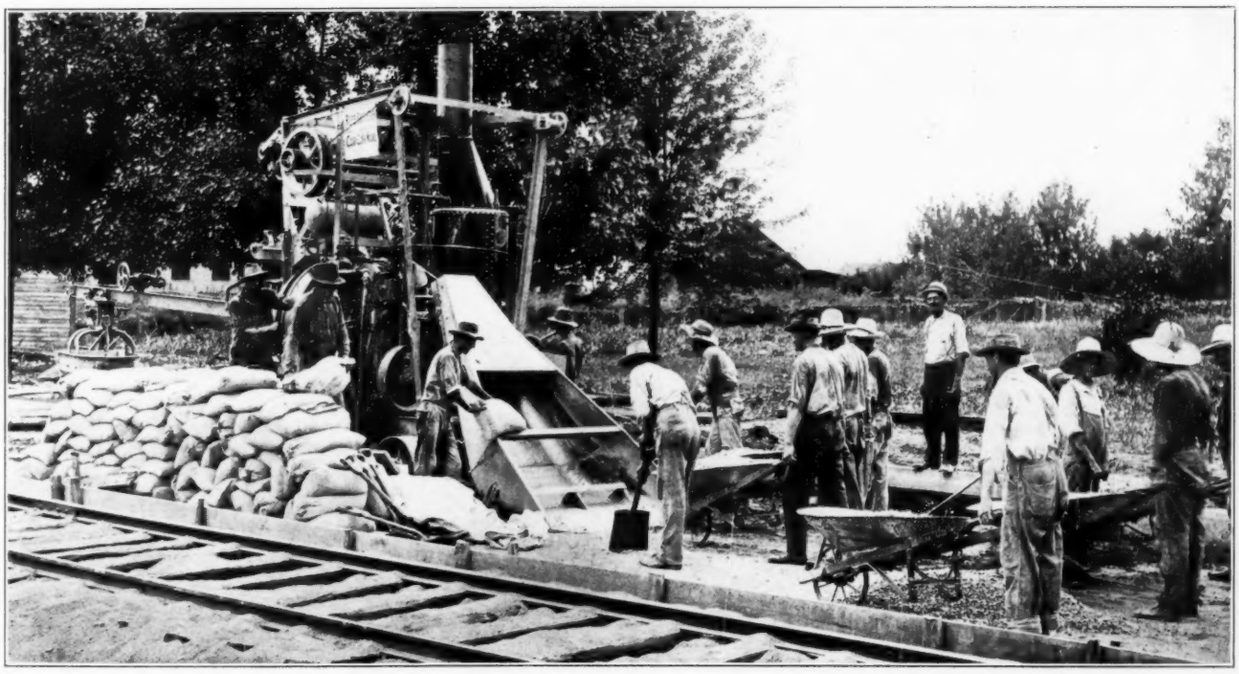
"We like the **Koehring** Loading Skip. It is ***non***-clogging.

"The materials are kept in agitation from the start of the skip—and the skip goes to a steep angle that shoots the aggregate into drum in a ***clean*** slide.

"Sheer angle of skip at charge is made possible by **Koehring** construction which passes the skip between the sheaves. ***Automatic*** brake stops and holds skip until released."

Koehring Machine Company

Milwaukee, Wisconsin, U.S.A.



"It's a Hill *Climber*—our 'American'

"And it goes almost ***anywhere*** and everywhere on the job," writes a prominent Western contractor.

"Our **'American'** leaves a clean, ***level*** floor in shallow excavation for subgrade, and when equipped with special dipper stick it ***digs*** sewers and trenches twelve feet deep.

"It's an all-round 20-ton Husky that shoves its full-yard (dipper) shovel through the ***hardest*** going.

"Although small and compact, it weighs enough to meet face to face the ***hardest*** shale digging in this State.

"Also used as a locomotive crane in a pinch. Our **'American'** is many machines in one.

"And it's the only ***real*** one-man shovel we know of."

American Clay Machinery Co.

Bucyrus, Ohio, U.S.A.

The Highway Economist

VOL. III. JANUARY, 1918. No. 8.

WHY 6 INS. OF CONCRETE AND 10 INS. OF BRICK? WHY SAME BASE FOR BRICK AS FOR ASPHALT?

4 Ins. Brick on 2-in. Base as Strong as 6 ins. of Concrete, and 4 ins. Brick on 1 in. Base as Strong as 3 ins. of Asphalt on 5 ins. of Concrete. Tests Prove Statements.

Estimates of Comparative Costs Based on Specifications Unfair to Brick and Prejudicial to Public Interest.

Why do engineers and state highway departments continue to specify brick pavements 9 or 10 in. deep and concrete pavements from 5 to 7 in. deep, and make these specifications the basis of comparative cost estimates?

Thorough tests have demonstrated that a 7-in. wire-cut lug monolithic brick slab, 4 in. of concrete base and 3 in. brick, or 4 in. brick and 3 in. concrete, will bear a load test of 14,293 lbs., as compared with a load-bearing strength of 12,815 lbs. in the case of a 7-in. concrete slab of the road type.

As the wearing qualities of a brick surfacing are far superior to the wearing qualities of concrete, it would seem to be in accordance with sound engineering judgment to take a 6-in. brick pavement—3-in. concrete base and 3-in. brick, or 2-in. concrete and 4-in. brick—as a basis of comparison with a 7-in. concrete pavement. The 6-in. brick pavement would bear as great a load as a 7-in. concrete and would wear longer.

But in almost all specifications drawn by state highway departments, and by many engineers as well, a much greater depth in inches of brick pavement is required than is required of concrete, and comparative costs per square yard are estimated on a level basis of surface measurements.

If an average of 6 in. of concrete is regarded as sufficient for a concrete road, why should engineers require 5 or 6 in. of concrete base, if 4 in. brick surfacing is specified in addition?

The only fair basis for computing comparative costs is upon the basis of beams of equal depth. Even on that basis a 7-in. monolithic brick slab has nearly one ton greater load-bearing strength than has a 7-in. concrete slab—a fact established by tests made by the most accurate scientific methods, on 7-in. wire-cut lug monolithic brick slabs (4 in. concrete, 3 in. brick) and 7-in. concrete slabs of the same size (23x45 in.)

A similar unfair discrimination is made against brick both in specifications and in estimates of comparative cost per square yard, when asphalt is in competition. It is customary to specify the same depth of foundation for a 4-in. brick surfacing as for a 3-in. asphalt surfacing, although asphalt has comparatively little compressive strength and very little tensile strength, and adds hardly anything to the load-bearing capacity of a pavement.

The inconsistency of requiring the stronger material to have a beam depth equal to and even thicker than is required for the weaker material ought to be apparent to every engineer, and it ought to be understood by the taxpayers, whose interests suffer by the existing practice.

So far as actual load-bearing strength is concerned, a 5-in. concrete base would be as strong without the asphalt covering as with it. As has been demonstrated by tests conducted at the College of Engineering, University of Illinois, a 4-in. wire-cut lug brick slab, 23x45 in., with no foundation and supported at the ends only, will bear a load of about 5,000 lbs. Why, therefore, demand that the same depth of foundation required for asphalt shall be used under a brick surfacing which alone will bear thousands of pounds weight?

In order to establish an equality between brick and asphalt on a cost comparison basis, a 1-in. concrete foundation and a 4-in. brick surfacing should be put in competition with a 5-in. concrete foundation and a 3-in. asphalt covering. Even then the superior wearing qualities of brick would make it by far more serviceable than asphalt.

The reduction of the depth of the foundation required by brick in order to put it on a load-bearing equality with concrete or asphalt, would effect a great saving in excavation, in quantity of materials used and in labor, as well as in time consumed in construction.

These are matters of practical engineering knowledge. They concern the public, which might have brick roads in many cases in which unfair specifications force contractors to bid on several inches of unnecessary excavation and foundation for brick.

Advantages of Monolithic Pavements

The monolithic and semi-monolithic types of pavement—as the green concrete foundation and the cement-sand bed types are called, respectively—are solid, practically noiseless, smooth, sanitary and durable. They originate no dust or dirt, are easily cleaned, and are not in any way affected by motor-vehicle, iron-tired vehicle traffic, or by surface moisture. A well-constructed brick pavement of either type neither becomes wavy nor slippery, nor pits, ruts, ravels nor disintegrates. It remains smooth and even on the surface and is good for all kinds of traffic.

Construction Features of Monolithic Pavements

The constructional features of a monolithic pavement are a wet concrete foundation reduced to a true cross-section, upon which the brick are laid and immediately rolled, culled and grouted. The object is to obtain a single rigid beam, all parts of

which are strongly united. In order to attain that end it is necessary to grout the pavement immediately after laying and rolling the brick, so that the grout filler, going to the bottom of the joints, shall form a homogeneous union with the green concrete foundation.

An essential feature, but one not always regarded in practice, is sprinkling the grouted pavement and keeping it covered with earth or straw for two or three days, so that the grout filler will not set too quickly and crumble.

Of course, as the concrete foundation is green, it is not feasible to use a heavy self-propelling roller for rolling the brick. A twin-cylinder hand roller, about 30 in. long, and weighing, when filled with water, about 800 lbs., gives the best results.

The green concrete foundation is brought to a true contour with either smoothing template or a tamping template designed especially for the purpose. Care must be taken in getting the surface of the foundation to the true contour of the surface of the completed pavement and at the right uniform depth below the surface contour. Care must also be exercised in assuring complete penetration of the grout to all parts of the joint and to the bottom of the brick, as strong bonding together of the brick and of the brick to the foundation are absolutely essential to good construction.

The foundation should be of proper consistency to bear up the brick when they are rolled, yet the moisture content should be sufficient to allow of easy shaping of the surface and to assure a perfect union with the brick surfacing. A foundation too dry is difficult to shape smoothly and it is liable to contain voids and lack uniform density.

No arbitrary rules can be laid down for mixing the concrete for the foundation. Each engineer must exercise discretion in the use of water, so that the concrete shall be of the proper consistency. A little experience or close observation will enable the engineer to fix the amount of water to use; but one detail cannot be neglected: The concrete must not be carried in a barrow for dumping; it must be put in place with the least possible chance for separation of the components.

Owing to conditions produced by the war it is not practicable to give reliable cost data for monolithic brick pavements. The length of hauls, the prices of materials and the price and available supply of labor are so unstable and they vary so much at different points, that estimates made for one point or for one period of time may not be serviceable at other points or at other times.

Quantitative Data

Quantitative estimates are all that can be made with confidence at this time.

Wire-cut lug brick lay 40 to the sq. yd., or 25 sq. yds. to the thousand. Assuming that a 4-in. concrete foundation mixed 1:3:6 is designed, approximately 0.123 of a barrel of cement would be required per sq. yd. For grouting, 1 to 1 mixture, the requirement per sq. yd. is 0.037 of a barrel of cement. For a sand-cement bed, 1 in. thick, 1 to 4 mixture, designed for semi-monolithic pavement, 0.051 of a barrel of cement is used per sq. yd. The cost of sand or gravel depends upon the proximity of the supply and local market quotations.

There is a tendency on the part of some engineers to use a stronger mixture for both foundation and cement-sand beds, 1:2½:5 for the former and 1:3 for the latter. In that case it would require 0.144 of a barrel of cement per sq. yd. for the base and 0.065 of a barrel of cement per sq. yd. of area for cement-sand bed 1 in. deep.

PAVEMENTS
THAT WILL BECOME FAMOUS - - NO. 2

In 1942 (or thereabouts) the paper, featuring *famous* pavements, will not omit mention of Calhoun St., Fort Wayne, Ind.—one of the heaviest traffic streets of the Middle West. ***Permanently*** paved with **Metropolitan Block** in 1910, it is in as good condition today as when first opened to traffic.

Metropolitan Block is the accepted *Standard* by which all other paving block is judged! **Metropolitan Block** is made from Metropolitan shale—Nature's ***finest*** product for paving block.

ALSO BESSEMER REPRESSED OR WIRE-CUT LUG

"Best Paving Block Made"

The METROPOLITAN PAVING BRICK CO.,
"The World's Largest"
CANTON, OHIO.

Robbins – Coaldale – Graves

Wire-Cut Lug Brick

When you lay *Wire-Cut Lug Brick* streets or roads, you can spend your maintenance fund in getting new mileage, not tinkering the old.

Southern Clay Mfg. Co.

CHATTANOOGA, TENN.

Clinton Wire-Cut Lug

Meets *all* traffic conditions!

Clinton Vitrified Shale is uniformly high grade—it has been "proven best" in years of service!

Clinton Paving Brick Co.

CLINTON, INDIANA

Springfield Wire-Cut Lug

IS WIDELY USED

The square edges *stay* square, due to the spacing lugs and beveled ends. Both Dunn Wire-Cut Lug and Frost Process. Sewer and Building Brick—also very artistic Rug Face Brick.

Springfield Paving Brick Co.

SPRINGFIELD, ILLINOIS

MEDAL BLOCK
"The Block with Experience behind it"
BUYING cheap goods to save money, is like stopping the clock to save time; and this applies to many types of road surfacing material. If you want the only sure, durable and reliable road surface, buy
MEDAL BLOCK
"The Block with experience behind it"
Manufacturers of Medal Block for 23 years.
Manufacturers of Paving Brick for 29 years.
Oldest in service unexcelled in quality.
Medal Repressed, Wire-Cut-Lug and Hillside Block.
23 YEARS SERVICE
MEDAL BLOCK
Capacity 55,000,000 annually.
THE MEDAL PAVING BRICK COMPANY
FORMERLY THE DECKMAN-DUTY BRICK CO.
1305-1308 Swetland Building
Cleveland, Ohio

Wire-Cut Lug Brick Require Shallower Base Than Any Other Surfacing!

Scientific tests show that Wire-Cut Lug Brick with Rigid Construction have *greater* load-bearing strength than other road materials tested.

Shallow Base *economizes* in excavation and in quantity of material used for artificial base.

Equal strength of beam and *less* cost of construction.

Wire-Cut Lug Brick are made by the following independent companies, operating 72 plants in 12 States:—

—LICENSEES—

Corry Brick and Tile Co., Corry, Pa.
United Brick Co., Greensburg, Pa.
Sterling Brick Co., Olean, N. Y.
Danville Brick Co., Danville, Ill.
Clinton Paving Brick Co., Clinton, Ind.
Alton Brick Co., Alton, Ill.
The Medal Paving Brick Co., Cleveland, Ohio.
Metropolitan Paving Brick Co., Canton, Ohio.
Peebles Paving Brick Co., Portsmouth, Ohio.
Murphysboro Pav. Brick Co., Murphysboro, Ill.
Southern Clay Mfg. Co., Chattanooga, Tenn.
McAvoy Vitrified Brick Co., Philadelphia, Pa.
Windsor Brick Co., Akron, Ohio,
Hocking Valley Brick Co., Columbus, Ohio.
Veedersburg Paver Co., Veedersburg, Ind.
Springfield Paving Brick Co., Springfield, Ill.
Terre Haute Vitrified Brick Co., Terre Haute, Ind.
Albion Vitrified Brick Co., Albion, Ill.
Alliance Clay Product Co., Alliance, Ohio.
Westport Paving Brick Co., Baltimore, Md.
Mack Mfg. Co., New Cumberland, W. Va.
Hydraulic-Press Brick Co., St. Louis, Mo.
Barr Clay Company, Streator, Ill.
Burton-Townsend Co., Zanesville, O.
Trimble Paving Brick Co., Dayton, Ohio.
Thornton Fire Brick Co., Clarksburg, W. Va.
Indiana Paving Brick & Block Co., Brazil, Ind.
Standard Brick Co., Crawfordsville, Ind.
Shawmut Paving Brick Works, Shawmut, Pa.
Pennsylvania Clay Co., Pittsburgh, Pa.
Clydesdale Brick & Stone Co., Pittsburgh, Pa.
The John Kline Brick Co., Wickliffe, Ohio.
Streator Clay Manufacturing Co., Streator, Ill.
Martinsville Brick Co., Martinsville, Ind.
Cleveland Brick & Clay Co., Cleveland, Ohio.
Jamestown Shale Pav. Brick Co., Jamestown, N.Y.
Purington Paving Brick Co., Galesburg, Ill.
Georgia Vitrified Brick & Clay Co., Augusta, Ga.
F. R. Carter, Peoria, Ill.
C. P. Mayer Brick Co., Bridgeville, Pa.
Athens Brick Co., Athens, Ohio.
Albion Shale Brick Co., Albion, Ill.
Copeland-Inglis Shale Brick Co., Birmingham, Ala.
Brick, Terra Cotta and Tile Co ; Corning, N. Y.
Medora Shale Brick Co., Medora, Ind.
Binghamton Brick Co., Inc., Binghamton N. Y.
Municipal Shale Br'k & Bl'k Co., Martinsb'g, W.Va.
Lake Shore Shale Brick Co., Ashtabula, Ohio.

Write for data.

THE DUNN WIRE-CUT LUG BRICK CO., Conneaut, Ohio.
(LICENSORS)

MOTOR TRUCKS

Motor Trucks as Used in the General Haulage of Construction Materials and Supplies.

STANDARD 5-TON CHASSIS AS OPERATED BY DETROIT WATER BOARD IN HAULING HEAVY CAST IRON PIPE.

Printed as insert to MUNICIPAL ENGINEERING, January, 1918.

A Hundred Thousand Men Toiled Twenty Years

to build the great pyramid of Cheops. Marvelous —and extraordinarily wasteful.

Today, in the pine forests of North Carolina, a monster MACK truck is doing the day's work of fifteen teams and twenty men.

A single MACK would have done the work of at least 200 slaves of Cheops. Five hundred MACKS would have replaced 100,000 men—and would have enabled the Egyptian king to break all records in pyramid building.

Right now, MACKS are speeding up work in engineering projects that dwarf the pyramid. MACKS hauled the sand and rock dug from the New York Subway tunnels. MACKS delivered granite for the piers of Hell Gate bridge. MACKS carried a 20,000 pound casting for the Carnegie Observatory up the steep winding road of Mount Wilson. The truck that does these giant jobs is the truck for you.

Write us for facts and figures.

INTERNATIONAL MOTOR COMPANY
New York

PERFORMANCE COUNTS

Economy

ECONOMY is a tremendous asset in a motor truck. But in too many cases economy is obtained at a sacrifice of power and stamina.

In Garford Motor Trucks you get not only enormous *power* and steady *stamina*, but in addition you get your *economy* so essential to the profitable operation of the hauling system.

Take the Garford illustrated above for example.

It is used on a twenty-five mile milk haul that formerly took *all day* with horses.

"I now make it in half a day—with less expense," says the satisfied owner.

Economy of time! Economy of upkeep! Efficiency greatly increased!

That's the kind of a record that talks.

And that's just the kind of a record Garford Motor Trucks are making in all parts of the country—in all kinds of work.

Garford Motor Trucks are built to carry any load from one ton to six tons.

Let the nearest Garford dealer show you which model will fit *your* business most economically. Also write us for descriptive literature. Address Dept. 107.

Garford Motor Trucks

The Garford Motor Truck Company, Lima, Ohio

Manufacturers of Motor Trucks of 1, 1½, 2, 3½, 5 and 6 ton capacity
4½, 7 and 10 ton Tractors
The Garford Road Builder
Distributors and Service Stations in all Large Cities

GMC trucks are built in all practical sizes, ¾-ton to 5-ton capacity — six sizes in all. Each size better suited than any of the rest for a certain class of work.

GMC Trucks Deliver the Goods—

Battling their way through blizzards and drifts, GMC Trucks push on in the scheduled routine of daily work.

Extreme conditions of weather or roads do not hamper their continued performance.

Ruggedness that is ***built in,*** power that is ***inherent*** back their effort—valuable insurance to their owners against costly service tie-ups.

Two well-founded reasons lie behind this exceptional GMC ability—First, the painstaking care, the attention to minutest details in GMC building;

Second, the years of experience in truck construction which have selected right principles and right materials.

Whether in the remote places traversed in cross-country traffic, or in the day-in and day-out grind of city haulage, GMC Trucks show the same built-in fortitude and endurance.

Eloquent testimony to their prowess is found in the many GMC Trucks now operating in every kind of trucking work, in every part of the country and under every condition of hauling.

The experience of others should guide you in your selection. Let ***your*** next truck be a GMC.

GENERAL MOTORS TRUCK COMPANY
One of the units of the General Motors Corporation
PONTIAC, MICH.
New York Philadelphia Boston Chicago
St. Louis San Francisco
Distributors Most Everywhere.

(286)

MOTOR TRUCK OPERATION AND ACCOUNTING XXIX.

By Charles A. Dickens

A uniformly successful application of motor trucks is in the general haulage of construction materials and supplies, such as sand, gravel, cement, brick, crushed stone, lumber, paving brick, water pipe, sewer pipe, and such construction requisites as coal and water. So extensive has been the use of motor trucks for this class of haulage that bodies and hoists best adapted to carrying and discharging loads of heavy loose materials have been devised. Some of the illustrations in these pages show these bodies and hoists in operation. Following are numerous specific examples of motor truck performance on the general haulage of construction materials.

Spreading Stone from Motor Trucks

Motor trucks have proved invaluable to road builders for hauling rock and gravel rapidly at low cost, but it was not until recently that a way was found to fit them for the class of work done by automatic spreading wagons. The latter are very valuable for distributing a small quantity of stone or gravel over the surface of a road in a thin sheet, or in a long, narrow strip where a rut has to be filled. If large quantities of such material are dumped in a pile on the road, the center of the pile forms a sort of hard core and will produce a hump in the finished surface of the road unless the stone is well harrowed after it has been spread by shovels. Until recently the motor truck could only deliver stone or gravel in such piles, for the chassis does not permit the use of hopper bottoms and similar contrivances such as are employed in spreader wagons. The deficiency has been overcome by providing the body of the truck with a tailboard having openings which can be closed more or less by slides. By raising the front of the body in the usual way, adjusting the opening in the tailboard to deliver a stream of stone of the right amount, and then running the truck at the speed which will give the correct amount of stone per linear foot of road, the truck will distribute its load satisfactorily. It takes a little experience for the driver to acquire skill enough to do the work well, but when this skill has been gained the work can be done rapidly. Such a distributing truck is owned by Davidson county, Tennessee.

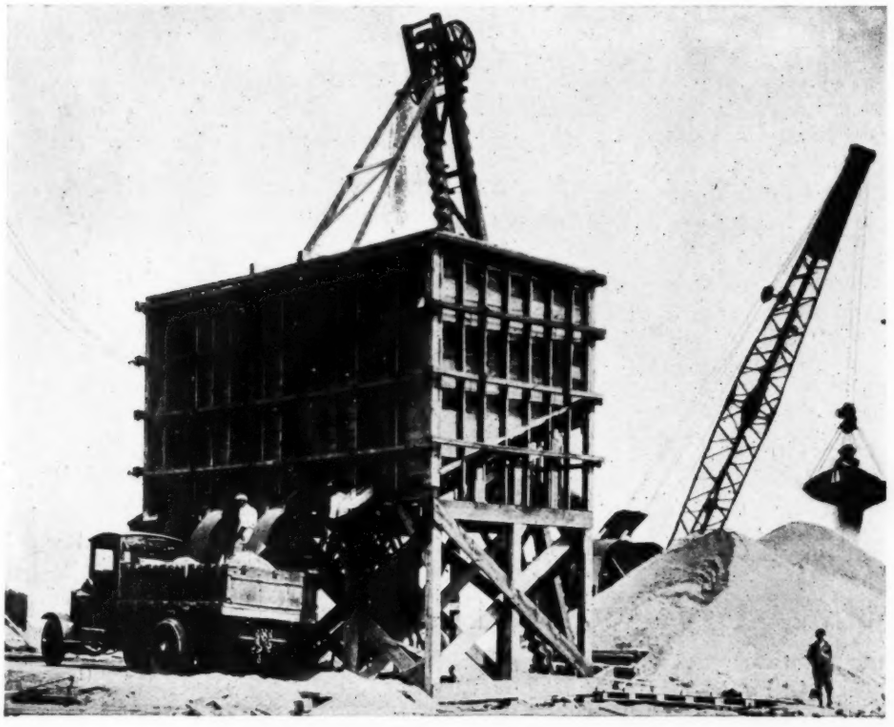
Hauling Sand to Detroit Paving Contractors

The Milburn Cartage Company has a contract to haul sand to the paving jobs of the Baker Paving Company, in Detroit. They use a heavy duty 5-ton Federal in connection with the work. This truck is equipped with a 5-yd. end dump body, controlled by Wood's hydraulic hoist. The wet sand hauled weighs about 2,900 lbs. per cubic yard—practically 1½ tons. To load the truck to body capacity of 5 yds. would mean a serious overload, so about 3½ yds. of sand is taken in a load. On this work the truck made seven round trips per day, each of 9 miles. Here are the figures for one day:

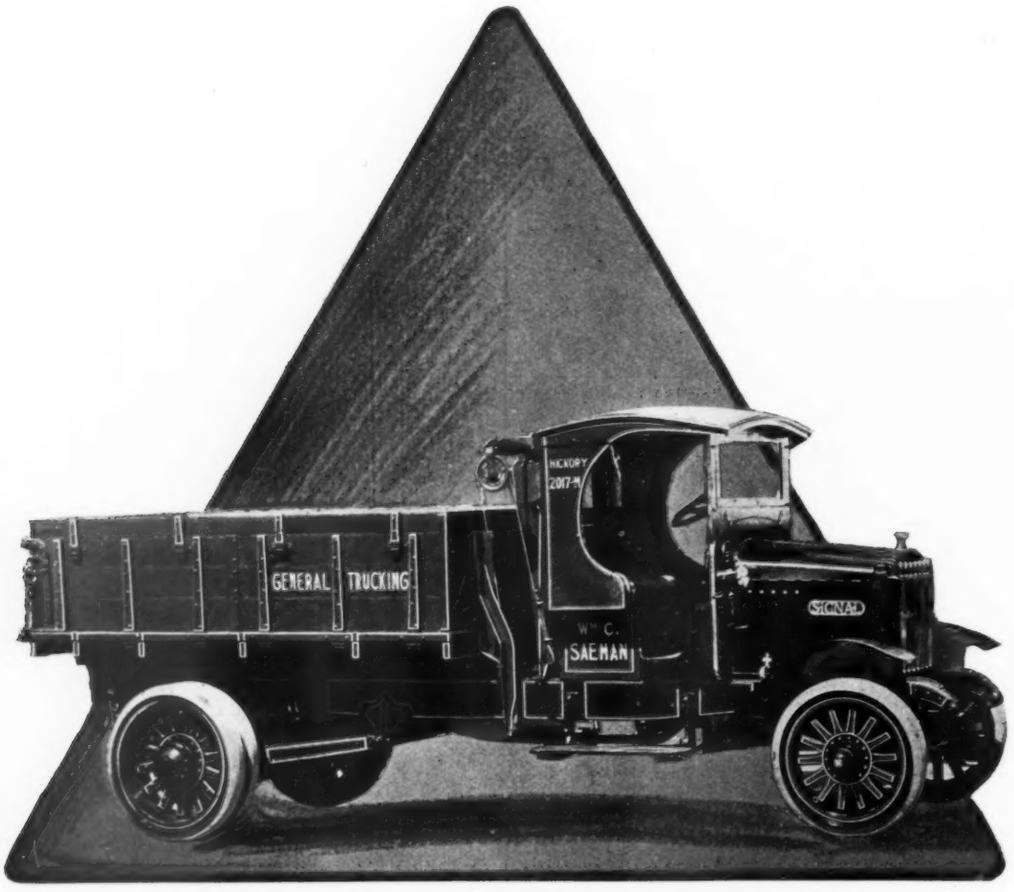
Round trips made	7
Tons hauled	35
Round trip mileage	9
Miles traveled per day	63
Ton miles, half-load basis	87.5
Cost per day	$14.85
Cost per ton	.42
Cost per ton mile	.17
Cost per mile	.23

The distribution of time per round trip was as follows:

	Hrs.-Min.
Backing in and pulling out at loading point	—06
Loading by steam shovel	—04
Dumping part of load at Smith street	—04
Backing in and pulling out of alley	—08



FEDERAL 5-TON TRUCK BEING LOADED WITH SAND AT ELEVATOR, AS OPERATED BY MILBURN CARTAGE CO., DETROIT, MICH.



SIGNAL

"*Fully* Loaded—*Every* Day

"Our **Signal** 3½-Ton Trucks master Steep Grades, Sharp Turns, Rough Going, at Low Cost.

"We haul almost anything and everything—anywhere. Our business is general trucking.

"That's why Absolute Dependability was the requirement when we went into trucks. **Signals** are all we could ask—they are averaging *More Miles* per gallon of gas and oil, *More Miles* per tire, *More Miles* per bearing than other trucks we know of."

Signal Trucks are so made that they *"Stand Up"* under Hard Usage and Rough Abuse.

Without sacrifice of power or loss of efficiency, **Signals** are Unusually quiet and Free from wasteful vibration at All speeds.

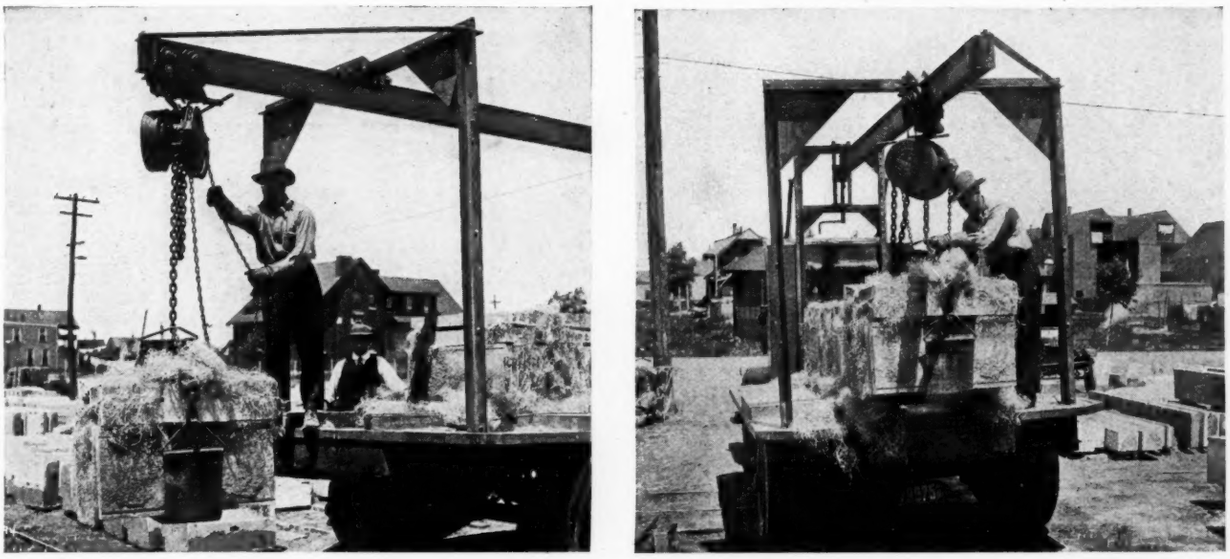
Signal springs are *Extra* Heavy (wide and long) yet Flexible to Absorb and Cushion jolts and jars encountered in Fast, Heavy Runs Over Uneven Roads.

"Our Signals have been in constant use for fourteen months and repair expense has been practically nothing."

Signal Trucks "Stand Up."

Signal Motor Truck Company, Detroit, U.S.A.

All sizes (1½-tons to 5-tons) and all Worm Drive! Continental motors, Timken-Detroit axles, Brown-Lipe transmissions, etc.



MACK 5½-TON TRUCK WITH OVERHEAD LOADING TRACK AND CHAIN HOIST OPERATED BY HYDRO STONE PRODUCTS COMPANY, CHICAGO, IN THE MARBLE, STONE AND BRICK TRADE.

Dumping load in alley	—04
Delays due to traffic in road	—04
Actual running time, round trip	1—00
Total time per round trip	1—30
Total time for seven trips	10—30

The cost given includes interest on investment, insurance, taxes, rent, driver's wages, gasoline, oil and supplies, allowance for repairs and maintenance, depreciation and tires.

Hauling Concrete Materials

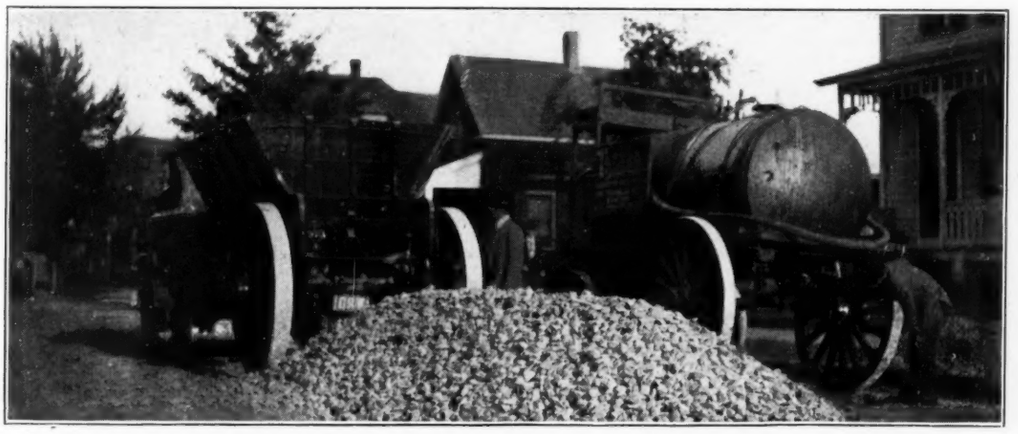
In Norfolk, Va., Addenbrook hauled over 3,000,000 lbs. of concrete materials in a month in a Federal truck, at a cost per ton of 15 cents, on an average haul of 2½ miles. Here is the record for the month in figures:

Days in service	25
Number of trips	407
Weight in pounds carried	3,048,750
Miles traveled	975
Tons delivered per day	60.9
Miles traveled per day	39
Round trip distance	2.4
Miles per gallon of gas	4.3
Cost per day	$9.50
Cost per mile	.24
Cost per ton	.15
Cost per ton mile	.13

Using Trucks to Haul Stone and Brick

A Mack 5½-ton truck with overhead loading track and chain hoist, as operated by the Hydro Stone Products Company, of Chicago, in the marble, stone and brick trade, is here illustrated. A screw adjustment on the front part of this appliance keeps the overhead track in a horizontal position, even though the truck is standing on a grade or uneven ground. One hand can operate the chain hoisting block unless the maximum load is lifted, when it ordinarily requires that a man use both hands for operating it. The chain hoist is of 2 tons capacity. The hauls are from 9 to 20 miles, and the truck averages 45 miles a day in addition to time spent in loading and unloading. It hauls 6 tons in a load. J. K. Harridge, president of the Hydro Stone Products Company, writes as follows relative to the use of this hoisting equipment in loading small pieces:

"We manufacture concrete blocks and concrete trim stone in all sizes and shapes. We have been studying the problem of economical handling of the smaller pieces of material and have handled them by packing from a ton to a ton and one-half in a platform which was hoisted directly to the truck and unloaded in the same manner, the number of platforms used depending upon the type of load. We are having built some boxes calculated to handle two tons of the smaller units; these boxes will be packed and spotted in place to be hoisted quickly to the truck. They will be unloaded at the job in the same manner; and if much hauling is to be done to a par-



WATSON 120 CU. FT. TRAILER AFTER DUMPING LOAD OF CRUSHER ROCK FOR ROAD CONSTRUCTION.

The Seal of Dependable Performance

ACME THE TRUCK OF PROVED UNITS

Trade Mark Reg. U. S. Pat. Off.

Keeps Truck Costs Down

In the various fields of municipal haulage, the powerful **Acme** performs dependably. Comparative figures show the **Acme** advantage. Users report astonishing economies. Special quick-unloading features save time and money,

Proved Units are a Service Bond

Acme proved units are the acknowledged perfections. Known to yield far greater, far more dependable service, at much lower cost per mile.

Timken Axles, Timken Bearings, Timken Worm-Drive, Continental Motor, Detroit Springs, Cotta Transmission, Pierce Governor, Ross Steering Gear, Long Radiator, Pressed Steel Frame—and so on. Each unit a master contribution to a master truck.

Write for a copy of *"A Pointer to Profits."*

Acme Motor Truck Company

112 Mitchell Street **CADILLAC, MICH.**

One-ton to Four-ton Models—each oversized in both capacity and dimensions.

GENERAL MOTORS 5-TON TRUCK CARRYING 100 BAGS OF CEMENT AND HAULING A LOCOMOTIVE AND TENDER WEIGHING 309,480 LBS., SEATTLE, WASHINGTON, WITH POWER IN RESERVE.

ticular job, these boxes will be left at the job for unloading and picked up on the next trip for reloading. We believe something of this kind would be found practical in the handling of brick and other materials as well. A box for handling sand, crushed stone, etc., can be set on the platform and the hoist used for raising the front end for dumping."

Hauling Sand in Pennsylvania

Lewis F. Kemmerer, of Lehighton, Pa., operates a Mack power dump truck in hauling sand. He hauls 7½ tons to the load over ordinarily good roads. The length of haul is ¾ mile and the truck makes from 25 to 35 trips per day with its 7½-ton load. He states that on the same work teams could not make over 10 trips per day with 3-ton loads. He is hauling as much sand with the one truck as could be hauled with 7 teams. The sand is loaded through a chute from a storage bin. He has operated this truck on icy roads when wagons would have "skidded and smashed to pieces," he says. The truck uses from 14 to 18 gal. of gasoline per day. The daily cost for oil is 80 cents and for grease 15 cents.

The Motor Truck Great General Purpose Machine

The great variety of uses to which the modern motor truck can be put is well illustrated by the varied performance of an Armleder truck in operation in Lincoln county, Kentucky, under the direction of J. L. McKee Riffe, road engineer. In two years this truck covered 11,500 miles without the expenditure of a dollar for repairs.

This truck stood some exceptionally severe tests. On one occasion it hauled 100 bags of cement—a heavy overload—without overburdening the engine. The truck was used with a trailer in hauling bridge steel, carrying 2 tons on the truck and 2½ tons on 36-ft. beams on the trailer. The truck was also used successfully as a source of power in plowing for ditching and handled a 6-ft. grader. The 2-ton truck averaged 7.6 miles per gallon of gasoline for all kinds of work.

Another Armleder with a splendid record in municipal service is operated by the city of Franklin, Pa. The car was put to work in July, 1916, and by the end of the year had gone 3,296 miles.

Much of the work at which the truck was used necessitated frequent stops, such as hauling a scraper or street sweeper. This also required a great deal of low-gear work, yet the mileage per gallon of gasoline was satisfactory. The truck, in six months, hauled a total of 946 loads, of which 737 consisted of ashes, 4½ yds. to the load, hauled an average of 3 1/10 miles. Cost of gas, $212.77; oil, $14.99; small supplies, $4.95, and repairs, $33.30. This proved to be a very much smaller expense than that made necessary by two teams in the preceding year. And the teams did much less work.

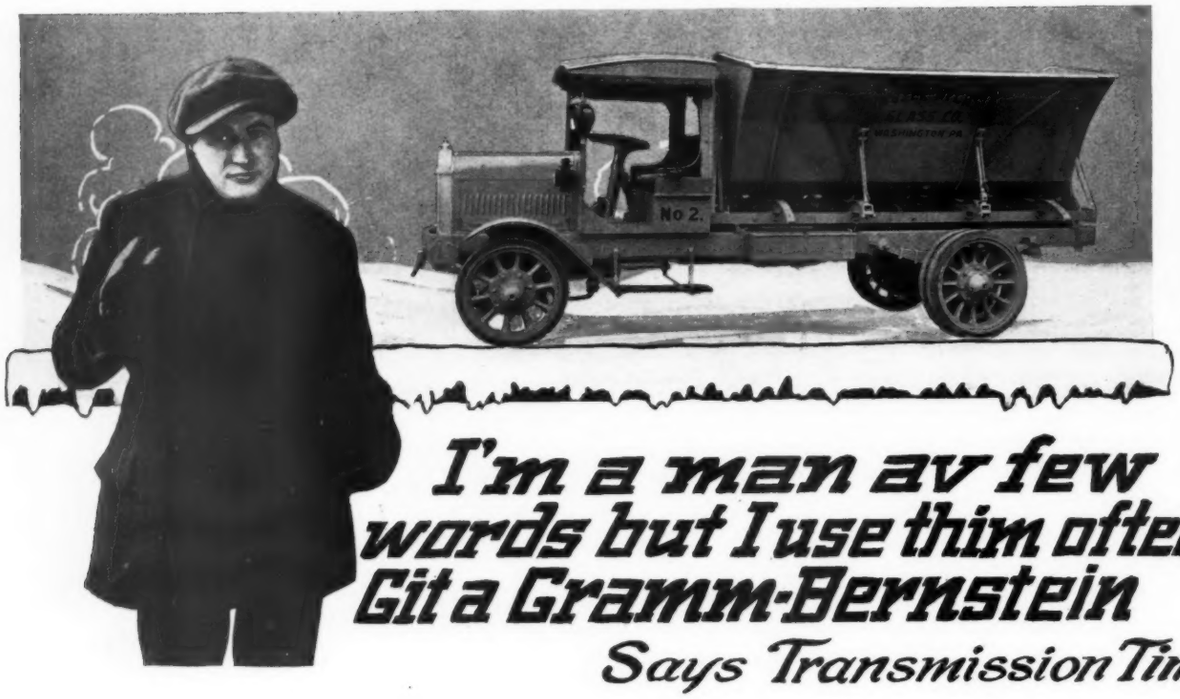
Hauling Brick in Detroit

The Hayes Cartage Company, of Detroit, Mich., operates a fleet of six Hall trucks. One of their 3½-ton Halls averaged 54 miles per day and made 7.4 miles per gallon of gasoline. A 5-ton Hall made 14 trips, carrying 3,000 common brick, and carried 42,000 brick in one day of 10½ hours. A team would make only four trips under the same conditions and haul only 6,000 brick. The truck practically did the work of seven teams.

Hauling Lumber in New York

It pays to haul lumber with motor trucks, even on short hauls, as the experience of John A. Wood & Sons Company, of Lawrence, Long Island, N. Y., demonstrated with a Federal 2-ton truck in hauling lumber to contractors.

U. S. 5-TON TRUCK AS OPERATED BY THE CAREY-REED COMPANY (CONTRACTORS), LEXINGTON, KY.



I'm a man av few words but I use thim often Git a Gramm-Bernstein

Says Transmission Tim

No Shifting of Gears!
No Stripping of Gears!!

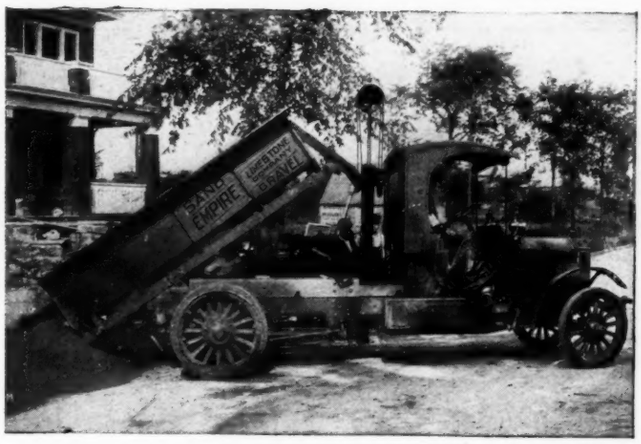
It's a Trouble-Proof Transmission.

THERE is *no* corner chipping, grinding, cracking or gnashing of gear teeth on **Gramm-Bernstein** trucks! There is *no* stripping of gears because the teeth are never out of proper contact, and there is *no* shifting of gears because the gears are *always* in mesh.

Speed changes are made through *extra* heavy high-carbon Chrome-Nickel steel dog clutches which are more than seven times as strong as gear teeth! And these G-B clutches *never* slip! G-B Control is *absolutely sure!* Positive insurance against reckless and inexperienced drivers.

These are just a few reasons why Gramm-Bernstein Trucks economically withstand the heavy strains and hard usage encountered in the contracting business—and at a surprisingly low fuel allowance. They are super-carriers without an ounce of superfluous weight. Write today about the G-B agency in your territory and the remarkable G-B sales co-operation.

The Gramm-Bernstein Motor Truck Co.
LIMA, OHIO.



PIERCE-ARROW 5-TON TRUCK, OPERATED BY EMPIRE LIMESTONE CO., BUFFALO, N. Y.

This truck is equipped with a stake body and one lumber roller at the rear. In operation a small roller is placed on the bed near the cab. This elevates the front end of the load a little higher than the rear and permits the driver to unload quickly. When the load touches the ground the truck slowly moves ahead and the lumber is soon on the ground.

Since May, 1917, the driver has been using Daily Service Records. For the first 4½ months' work the records show:

Days in service	97
Trips made	321
Deliveries made	682
Tons hauled	348.19
Miles traveled	1,438
Gallons of gasoline	257
Pints of cylinder oil	62
Loading time, hrs. and min	272.25
Running and delivery stop time	308.15

DUPLEX TRUCK AS OPERATED BY AXTON & SPRATTEN, STREET SURFACING CONTRACTORS, DENVER, COL.

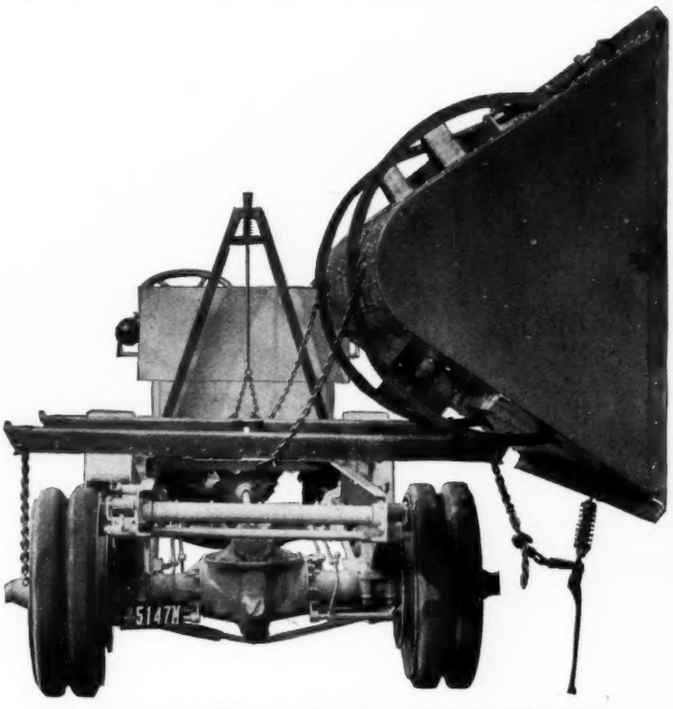
The daily averages were as follows:

Trips made	3
Deliveries made	7
Tons hauled	3.6
Miles traveled	15
Ton miles	9.00
Average trip distance	5
Miles per gallon of gasoline	5.6
Miles per pint of cylinder oil	23.19
Loading time per trip, minutes	.58
Delivery stop time, minutes	.17

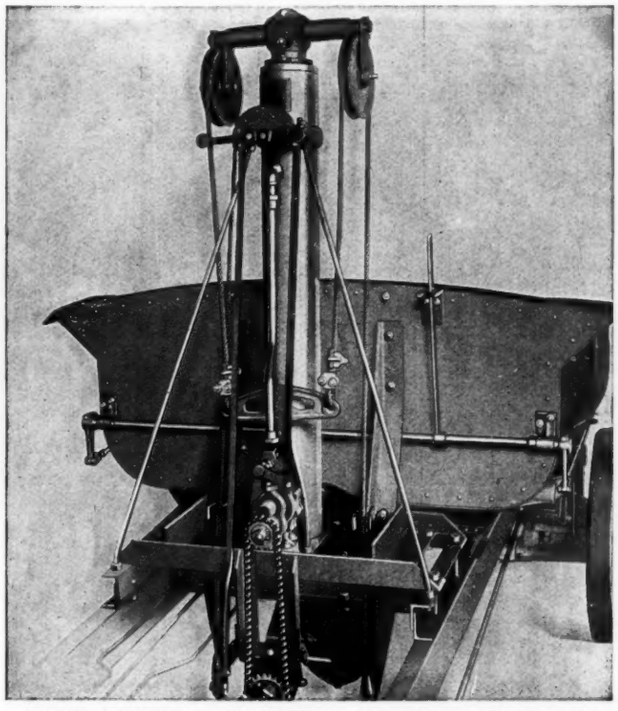
The efficiency of the lumber roller is well shown. While an average of 58 minutes were required to load, but 17 minutes were spent unloading. This includes all delays bound to occur when hauling to a building under construction.

The following cost of making these short hauls includes every item chargeable to truck operation:

Cost per day	$5.35
Cost per ton	1.47
Cost per ton mile	.59



STANDARD CHASSIS EQUIPPED WITH LEE TWO-WAY GRAVITY DUMP BODY.



VIEW SHOWING WORKING PARTS OF HYDRAULIC HOIST AS USED ON U. S. MOTOR TRUCKS.

U S
FLOATING POWER PLANT
MOTOR TRUCKS

Haul Your Stone
at a Cost Like This

Cost of operation is a much more important part of the cost of truck service than even a considerable difference in the price of the truck.

This cost has been very satisfactory in the case of the two-and-a-half-ton U. S. truck operated by the Newport Cut Stone Company.

The truck has been in service fourteen months and has traveled 6,500 miles; a gallon of gasoline has yielded an average of eight miles at a cost of .035 cents; oil and grease cost .0035 cents a mile; repairs $75 for fourteen months or one cent a mile.

The operating cost of the truck for an average day, including $3 paid the driver, insurance, interest and depreciation, is $6.48.

Are your trucks doing as well?

The Floating Power Plant—which protects U. S. truck motors from undue stress and high bearing pressures on rough surfaces—reduces operating expense.

Worm-Drive—2½, 3½ and 5-ton.
Chain-Drive—2½ ond 3½-ton.

The United States Motor Truck Company **Cincinnati, Ohio.**

New York Philadelphia Baltimore Pittsburgh
Cleveland Denver Detroit Chicago Atlanta
St. Louis Boston Minneapolis

Dealers in all Commercial Centers.

GRAMM-BERNSTEIN TRUCK OPERATED IN CONJUNCTION WITH STEAM SHOVEL ON CONSTRUCTION.

GRAMM-BERNSTEIN TRUCK HAULING EXCAVATED MATERIAL UP STEEP GRADE OF EXCAVATION.

Using Trucks on Road Construction

On road construction S. M. Billiter, of Williamstown, Ky., operates a United States 3½-ton truck and finds that it replaces six, seven and even nine teams, and it has also performed many extra and unusual services. The truck is fitted with a steel dump body, equipped with a hydraulic hoist. It is loaded from railroad cars by chute or from a pocket at the rock crusher. It is used efficiently; there is little waiting time, either to take on or discharge the load; it earns steadily. The expense of operation, including the driver, has never exceeded $6 per day.

In many other ways besides the simple hauling of material cheaply and quickly, the truck has aided its owner. In unloading, the tailgate is latched open a certain distance and the truck used to spread crushed stone on the roads. It makes the work and wages of two shovelers unnecessary.

When there is grading to be done the truck is used to supply power to operate the grader. It is used also to move heavy machinery from one location to another over the roads. On one occasion it moved a rock crusher weighing 14,000 lbs. in that way. The crusher was hitched on behind the trailer, which the truck also hauled.

With the cracks about the tailgate caulked with burlap, the truck has been used to haul water. In times of labor scarcity it was difficult to get men to travel several miles into the country in the morning and return at night when they could get jobs as good nearer home. But the truck enabled Mr. Billiter to keep a sufficient force when it was used to call for the men at their homes in the morning and take them back at night.

Truck Saves $2,400 in 198 Days Hauling Construction Material

The detailed cost record of the Model "J" 3½-ton worm-drive U. S. truck operated by Marion county, Missouri, shows that in 198 days of operation it saved at least $2,400, as compared to cost of doing the same work with horses.

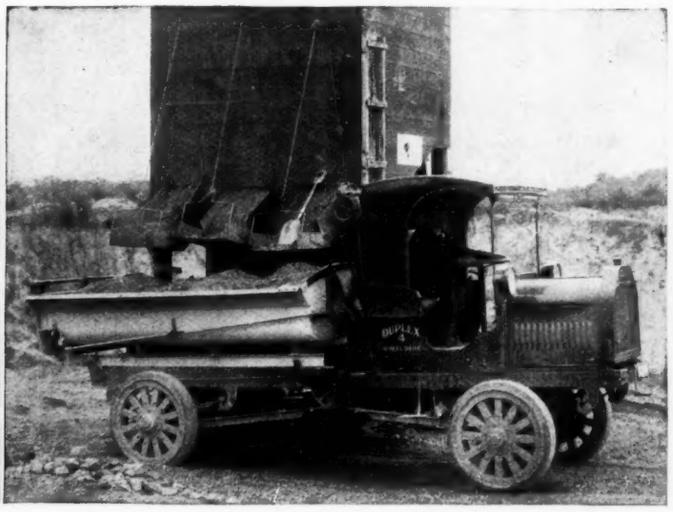
The figures given below show that the truck traveled an average of 37.611 miles per day at a cost of .223 cents per mile, or $8.30 a day.

For 100 days the truck was employed in hauling cement and steel. In 62 days 7,000 sacks of cement were moved at a cost, based on the average daily figures, of $504. If this work had been done with teams, allowing 25 sacks to a load and figuring 25 miles a day, it would have taken one team 420 days, which, at $4 per day, the current rate, would have been $1,680. The difference between $504.60 and $1,680 is $1,165.40, the amount saved by the use of the truck.

In 42 trips 240,000 lbs. of steel was hauled during 38 days, which, at $8.30 per day, cost $315.40. Teams would have required 100 trips in 150 days, and at $4 per day the cost would have been $600. This shows a saving of $284.60. The total saving on the hauling of steel and cement was $1,450.

On the remaining 98 days the nature of the work was so varied that it was found impossible to keep an accurate account of it. The truck moved machinery, tools, hauled lum-

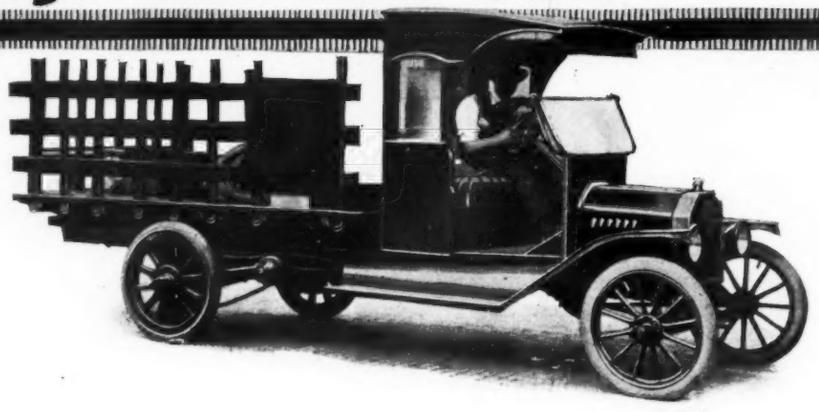
FEDERAL 5-TON TRUCK AS OPERATED IN CONJUNCTION WITH 2-YD. CLAM BUCKET IN HAULING SAND.



DUPLEX TRUCK AS OPERATED IN THE HAULAGE OF GRAVEL FOR ROAD CONSTRUCTION IN MICHIGAN.

Tonford

"Always On The Job"



"OUR two 'TONFORDS' are *Always* Johnnie-on-the-Spot in both City and Country haulage," says Mr. A. H. Hollander, Pres., Hollander Express & Van Co., Chicago. "They have all the weight necessary for ***strength***—but they're the lightest trucks for their capacity in the world; that's one reason why their Fuel Consumption is so ***Remarkably Low.***

"We've always maintained that excessive weight in ton trucks spelled Danger—and Needless expense.

"TONFORDS give us the ***Cheapest*** Haulage. They cost but half the price of ordinary ton trucks and one-half the up-keep cost.

"TONFORDS are ***oversize*** throughout for Dependable, Continuous service—it's a Real Ton Truck—at the right price.

"The attachment reinforces the Ford Chassis and transfers the load to the heavy truck frame and axles. There's no strain on the original Ford frame."

TONFORDS are *a sure cure* for the "high price" habit—they are the Cheapest Transporting Units of Equal Capacity and Strength in the World! A little thinking before you purchase ton trucks will save you Many Dollars—you'll have just as much haulage as if you paid the difference—plus the satisfaction of a Substantial Saving. Think it over.

Detroit Truck Company

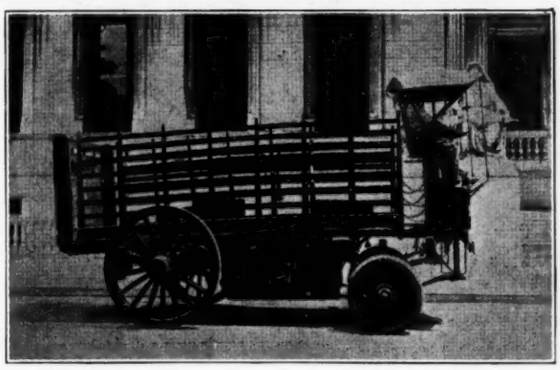
8th & Fort Street. DETROIT, MICH.

ber, gravel, rock, operated a road oiler, patched road, and moved heavy machinery. On some days at this work the actual travel did not exceed 15 miles. The saving was less. But on the basis of an average of $14.50 per day, while the cement and steel were hauled, the county authorities estimate it at $9.50 per day for the 98 days. This brings the total saving up to $2,400 a year, and the figures do not make an allowance for depreciation on the truck.

The expenses are tabulated as follows:

Driver	$ 595.72
Helper	304.05
Repairs	126.37
New set rear tires	195.00
Gasoline, 1,774 gal.	370.02
Oil and grease	53.21
	$1,644.17

Miles traveled	7,347
Gasoline, gallons	1,774
Time worked, days	198
Average distance	37.611
Mileage per gallon	4.144
Gasoline per day	8.954
Operator and helper per day	4.54
Daily cost of repairs, tires, oil	1.89
Daily cost of gas	1.86
Total	8.30
Average cost per mile	.223



Couple-Gear

Front and Four-Wheel Drive (Trucks and Tractors) keep out of the repair shop. They cost 50 per cent less to operate than gasoline trucks and 25 per cent less than any other type of storage battery truck.

97 Per cent of the power is applied at the point of traction. Load strain is taken off the driving mechanism. But let us send you the illustrated story.

COUPLE-GEAR FREIGHT-WHEEL CO.
GRAND RAPIDS, MICH.

Chicago Sales Agents—Couple Gear Power Truck Co.
1029 Peoples Gas Bldg.

NO GRADES TOO STEEP FOR THE DUPLEX 4-WHEEL DRIVE

Sturdy and dependable, with irresistible reserve power, Duplex 4-Wheel Drive Trucks begin their notable haulage tasks where other types of commercial vehicles leave off. Exclusive application of the Duplex 4-Wheel Drive principle makes it possible for Duplex trucks to haul capacity loads under conditions that prevent the operation of any other type of heavy haulage vehicles.

No grades are too steep; no roads too snow-embanked; no sand or mud too deep for the Duplex—the motor truck that is equal to any emergency.

Duplex trucks are built especially for manufacturers, contractors and road builders—and are delivering capacity loads at lowest ton-mile costs. Let us send you data showing how profitably the Duplex is solving haulage problems in your line of business. Write for our catalog and the heavy haulers' magazine, "Duplex Doings," issued in the interest of better transportation methods. Address all communications to Dept. 112.

Duplex Truck Company, LANSING, MICHIGAN.

GOOD TERRITORIES OPEN FOR GOOD TRUCK SALESMEN

WE have some good territory open for reliable Truck Distributors. An exceptionally liberal proposition is offered you to take on the **American** Line of Trucks. And immediate deliveries guaranteed!

AMERICAN MOTOR TRUCK CO.
DETROIT, MICH.

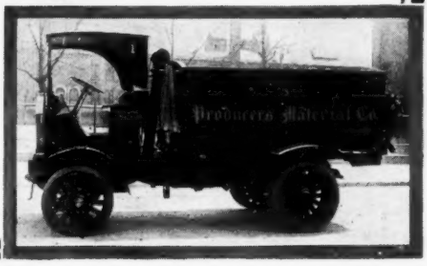
Write us for the territory you want.

Dump Truck Powered *with* Wisconsin Motors

CONSISTENT

The standard power for municipal trucks
Write for specifications on different types and sizes.

WISCONSIN MOTOR MFG. CO.
Station A. Dept. 330
MILWAUKEE, WIS.
New York Branch,
21 Park Row,
T. M. FENNER, Factory Rep.



The Truck that Captured New York

New York is hard to convince, and the purchasing agents of the large corporations are harder still; yet, in six years of actual manufacturing, the **Hurlburt Motor Truck Company** has assumed the leading position in New York City. Twice (during 1917) it was necessary for us to speed up production and to increase the size of our plant. We will produce approximately 2000 motor trucks in 1918. ***We have a few valuable territories open.*** Our new 116-page, leather-bound catalog will be sent to those interested.

Hurlburt Motor Truck Company

Third Avenue and Harlem River **NEW YORK CITY**

The above three and one-half-ton Federal is being used by Wheeler & Dreher, Atlantic City, to complete a paved road from Philadelphia to Washington, D. C.

Road Building Work Proves Federal Stamina

In few lines of work is the stamina of a motor truck tested so severely as in the heavy work of road building.

Because of their sturdy construction, economy and day-after-day reliability, Federals are used extensively in this type of work.

That their performance is uniformly satisfactory is proved by the large percentage of owners in this line who increase their haulage fleet by ordering "Another Federal".

Let Federal traffic engineers analyze *your* haulage problem for you.

Federal Motor Truck Company

351 Federal St. DETROIT, MICH.

FEDERAL

One to Five Ton Capacities

"SPEED UP with a SCHACHT"

Schacht Trucks *"Stand Up"* even though you *"Speed Up"* under *heavy* overload!

Your working conditions are *abnormal!* That's why ordinary trucks won't do.

You must have *super* axles. Every part must be *extra* large. Oversize. *Abnormally* strong. That's why ordinary trucks for ordinary road speeds and ordinary load strains won't stand up in the contracting business.

Remember there are no air cushions to soften Jolting Jars and Smashing Shocks as your joy rider sends your high-powered, heavy truck grinding over rotten roads.

That's why you *need* **Schacht** Trucks —they *"stand up"* while you *"speed up"* because they're *made* that way.

Dig into **Schacht** vitals! You'll find your *reasons* why they pull through deep, rain-softened roads—why they are "equal to *any* emergency in the contracting business."

Every **Schacht** truck goes through tests *more* severe than your actual operating conditions—and on this *super-test* the **Schacht** guarantee is based.

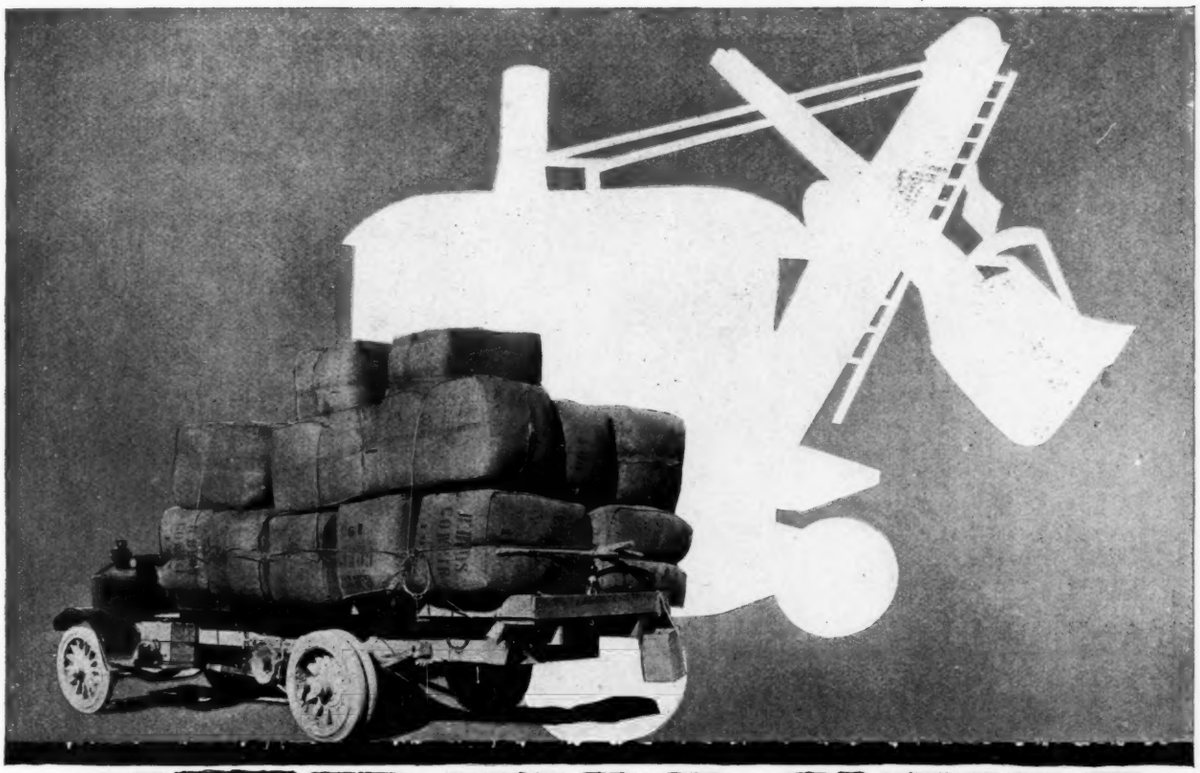
And don't forget we *make* **Schacht** trucks (they're not assembled). No matter whether 2-ton, 2½-ton, 3½-ton or 5-ton, **Schacht** trucks are the *best* truck buy on the market—and we can prove it!

You'll get Quick Deliveries on Schachts.

***Some territories are yet open, and in these* Schachts *will sell Quickly because they are Especially suited to contract work, and because we can fill orders* immediately! Get Details!**

The G. A. Schacht Motor Truck Company

CINCINNATI, OHIO, U.S.A.



STRENGTH

Stability! That's the Dominant Feature of HALL TRUCKS. Mechanical Ruggedness! We build them Many times *Stronger* than necessary. That's why HALL Trucks ("the Big Brutes of them all") are Super-Carriers. Their Stamina, *Excess* Power, Economy and Freedom from road troubles won them the *Hardest* jobs. Hard Driven! Over-Loaded! Plowing along in Deep sand, snow and mud stretches, HALL Trucks Are Operating Continuously Day and Night (for months) "Without A Cent's Up-keep for Repairs." A truck "On The Job" is worth any number in the garage—HAUL IT IN A HALL.

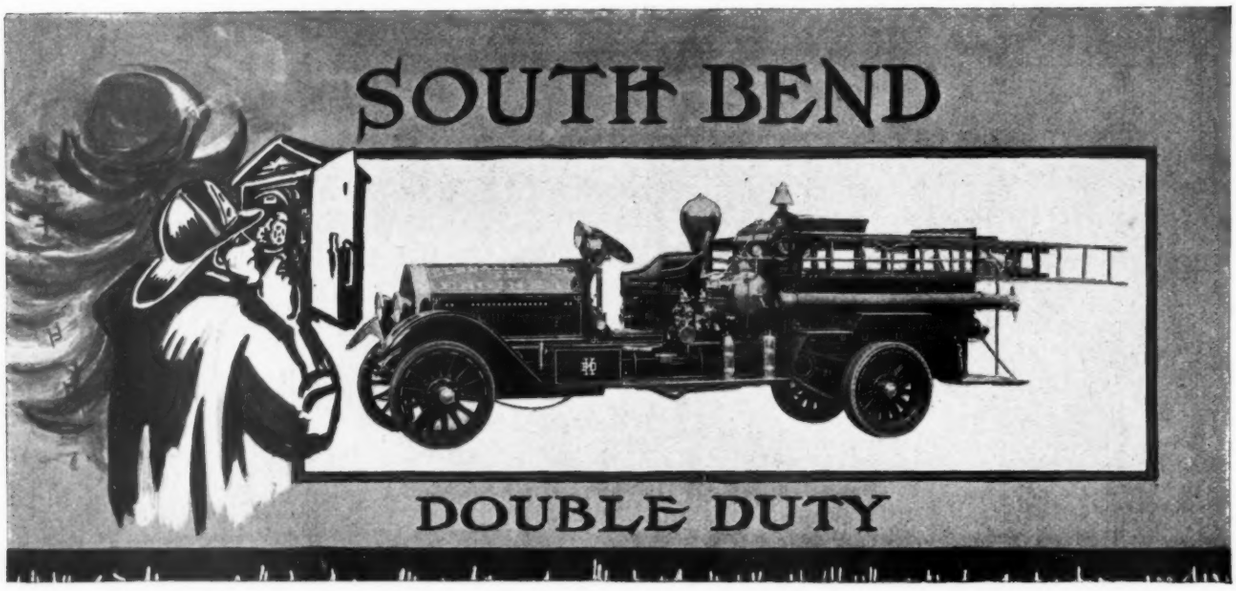
THE LEWIS-HALL IRON WORKS

Manufacturers of the HALL Truck

(Established 1873)

Ferry Avenue and Grand Trunk Ry. **DETROIT, MICH.**

Boston Distributor: E. A. Robinson, 1123 Commonwealth Ave.



AT any speed—up hill or down—rough roads or smooth—South Bend "Double Duty" Fire Apparatus rides like constant *coasting.* Its Marvelous spring adjustment, its Unusual balance, its motor Smoothness means a Vibrationless, Gliding ride which not only protects your apparatus but you! *It's like Flying!!*

Chiefs who ride on South Bend "Double Duty" appreciate its ***Quick*** Get-away—it enables them to get thru city traffic much ***More*** Quickly and dodge in-and-out and around street cars and pedestrians.

No matter whether it's Express Train Speed or Tortoise Crawl—you get it in a jiffy in South Bend "Double Duty"—Each and Every piece is a piece of ***real*** fire apparatus made by experts who do nothing but make fire apparatus.

No make-shift contraptions ever bore the name "Double Duty" and ***They Never Will.*** If you would know how scores of chiefs are protecting themselves against mishap by the matchless strength of "Double Duty" (doubly dependable) construction, send us your address and we'll place you on our regular mailing list.

Eastern Representative: WALTER M. HELLER, 142 Market St., Newark, N. J.

SOUTH BEND MOTOR CAR WORKS
HEADQUARTERS—MOTOR FIRE APPARATUS
SOUTH-BEND INDIANA

"Sixty-Eight Mile runs over spongey Iowa roads have no terrors for the **Master** Truck," states Mr. H. E. Whitlatch, of Whitlatch Bros., Concrete and Structural Bridge Contractors, Beacon, Iowa.

"And it has made such trips not a few times but many times. Other truck owners invariably predict that we will never get back—but we always do! And with no difficulty whatever! And all because our **Master** Truck is 'The Master of the load on any road.'

"It's not what you pay for a truck—it's what you get for what you pay, and we know of no really reliable 2-ton truck at as low a price as the **Master** truck. But it is really a 3-ton truck. That's why we didn't pay a 3-ton price."

Master 2-ton trucks at $1990 represent full money's worth of reliability, all-year-round haulage with nothing added to the price. That's why hard-headed contractors are flocking to the **Master**—they're getting value for every cent spent.

Each and every **Master** part is not only oversize, but is most carefully constructed from only the highest quality materials obtainable. **Master** trucks are not makeshift contraptions. They "stand up" and "deliver" on the extra hard pull! You can always count on a **Master** for the supreme effort at the top of the hill.

MANUFACTURED BY

MASTER TRUCKS, Inc.

3132-3136 Wabash Avenue. CHICAGO, ILL.

Acason
THE OWNER FIRST

Acason
THE OWNER FIRST TRUCKS

TRUCKS

TRUCKS

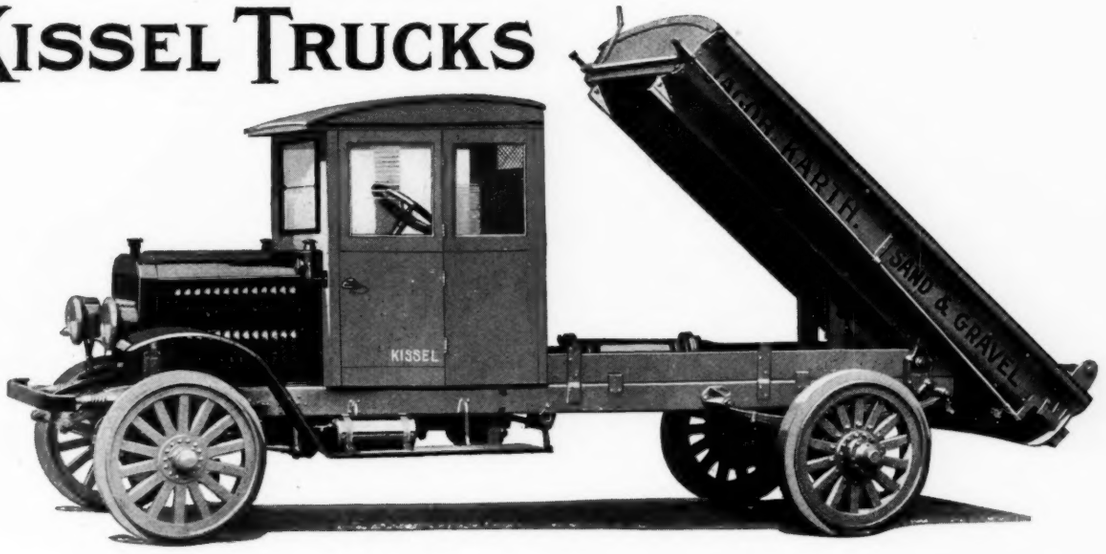
The line of Trucks built by this Company, its service policy and its method of dealer co-operation, and its ability to make prompt deliveries, constitute a truck proposition that is rapidly adding to the **Acason** organization the best type of truck dealers.

There is open some very desirable territory for dealers of this kind. We suggest that you investigate our proposition.

ACASON MOTOR TRUCK CO.
DETROIT, U.S.A.

THE OWNER FIRST

KISSEL TRUCKS



All-Year Motor Trucking Efficiency for Contractors

KISSEL Trucks in contractors' service prove their *in-built* quality by continuous performance 365 days in the year.

The exclusive Kissel combination of perfected worm-drive rear axle, superior front axle, powerful Kissel-built power-plant, dependable brakes and reliable heat-treated chassis, insures that efficient service contractors expect from their trucks.

Under the most difficult loading and unloading conditions, where unlimited power and perfect traction is a vital necessity, Kissel Trucks prove more than equal in meeting those unusual conditions that are characteristics of contracting work.

Kissel Trucks are made in five new sizes—insuring the right size for every contractor's requirements.

The ALL-YEAR Cab insures increased results for contractors

No longer are contractors subjecting their truck drivers to incomplete protection in cold and wet weather. The ALL-YEAR Cab provides a warm enclosed housing that is cold-proof, wet-proof and wind-proof, giving drivers full protection at all times. In summer it becomes an open, cool cab by removing the winter attachments.

See your nearest Kissel dealer for full particulars regarding the new line of Kissel Trucks and the ALL-YEAR Cab, or write us for literature and specifications.

KISSEL MOTOR CAR COMPANY, Hartford, Wis., U.S.A.

The truck for the buyer with a knowledge of values

IT has never taken a lot of talk to sell United Trucks because their *performance* kept us busy making them. The United is not a *new* truck—but one that made an international reputation for stamina, power and endurance before we had the facilities for supplying other buyers who wanted them.

Before you buy a truck, send for our catalog and compare the highest priced trucks on the market with the United. Specification for specification the United is unexcelled at any price.

UNITED TRUCKS

2-Ton
$2350

3½-Ton
$3150

4-Ton
$3450

5-Ton
$4250

The United has tremendous *excess* power. We make every truck show its colors under a gruelling cement-block test, that is, a chassis loaded with great cement blocks. Then the United must come through, handle the big excess load easily in mud, over sandy hills, through the worst pulling we can find.

When you put a United motor under an extraordinary load, you know the excess power is there for just such an emergency. The United will save you money. Low cost per ton mile is a fact. You get it in a perfect mechanical unit throughout, extreme engine power, worm gear drive. The United is consistently good all the way through.

Send for Catalog—Prompt Deliveries

The United comes in the following capacities: 2-ton, 3½-ton, 4-ton, 5-ton. We furnish any type of body desired. Dump bodies a specialty. We can make prompt deliveries. Send for catalogue and specifications now.

UNITED MOTORS COMPANY, 690 North Street, Grand Rapids, Mich.

VOL. LIV.
No. 1.

Municipal Engineering

CHICAGO, ILL.
JANUARY, 1918.

Design, Construction, Operation and Maintenance of all Public Works

Can We Learn From England and France?

Our own Benjamin Franklin said: "Experience keeps a dear school, but fools will learn in no other." The frankest critic hardly will assert that we are not willing to learn from the experience, and profit by the mistakes, of others, but a serious question may fairly be raised as to our ability to learn from others.

At the time the United States entered the war, and the British and French advisory commissions visited this country, Americans congratulated themselves at their good fortune in being told of British and French mistakes so that we could avoid making the same mistakes. Yet we read that many skilled workers, much wanted in industry, were drafted into the National Army as common soldiers. This was one of the best advertised of the British mistakes, one well known at least two years ago to all American citizens who read the newspapers. Still we persisted in making the same mistake.

Are we going to insist on making the same mistakes as England and France in curtailing public improvements? Sometimes it seems so. In those countries improvements were much curtailed on the outbreak of hostilities and there is small wonder, for those unprepared countries were under the necessity of withstanding the sudden and terrific assault of the well-prepared enemy. Here no such emergency existed, yet we are disorganizing industry almost as thoroughly as though the Hun were actually at our gates.

At the beginning of the war, for example, Great Britain concentrated her energies on war work and neglected to continue the work of highway construction and maintenance. The roads soon became so bad that war efforts were seriously crippled, and men were withdrawn from military service and sent home to repair existing roads and build new roads where necessary.

France did not make this particular mistake—the French appreciated the military value of highways from the beginning. They saw no conflict of interests between war work and highway work but perceived that the two activities were inseperable. France has kept a large force of men constantly at work on highway construction and maintenance, not only at the front but throughout the nation. As a result of this wise policy, the French railroads have been relieved of great burdens and much of the ordinary haulage of freight has been handled by motor trucks on the highways.

England curtailed road construction and was wrong, as events proved, and we know it; France increased her road building activities and was right, and we know it. Yet unless Priority Order No. 2 is lifted we will be deliberately choosing the wrong course. England was wrong; France was right. Can we learn from England and France?

English and French cities, too, passed through their period of restricting the construction of public improvements, just as so many American cities are doing today. They have seen their mistake. Can we see it, too, or must we learn by making exactly the same mistake?

Two or three years ago it was when we first read of comprehensive preparations for peace in England and France. The planning of public improvements, to be made during and after the war, is an important part in the preparation for the return of peace with its economic and social problems.

The French Senate recently passed a law compelling every French city to lay out all its future development along modern city planning lines. Since the war began Paris created a city planning bureau with broad powers which has developed comprehensive plans not only for the entire city but for the surrounding area. Other French cities have been equally alert. In Limoges four and five story tenement buildings, covering an area of six acres, were recently torn down at a cost of millions of francs, in order to make way for broader streets and to rebuild the district along modern lines. The city of Marseilles has spent $8,000,000 replacing tenement districts with broad streets, open spaces and modern buildings.

Since the war began London has worked out comprehensive plans and traffic routes for nearly two thousand square miles around the city. In England it is held that the end of the war must see an enormous expansion of building activities and pressure is being brought to bear on public authorities, national and local, to plan and initiate these things now. The British hold that the need for action in development plans is sufficiently great in normal times, and that the abnormal conditions produced by the war have made it even greater.

And what of Belgium? If any nation could be excused for temporizing certainly Belgium is that nation. But the Belgians are forward-looking people who are preparing for peace. The leading Belgians are now preparing plans for great civic improvements and one expert is in this country securing data and information on our normal methods.

Fortunately many Americans are also awake to the desirability of planning and carrying on public improvements at this time. The Chicago Association of Commerce, for example, while giving its energy to whole-hearted support of the war problem, has tried to learn by the experience of our allies in the making of public improvements. Recently the president of that association pointed out that any study of the municipal affairs of the European countries, who have been

through over three years of intensive warfare, will show conclusively that part of the war program has been the planning of large municipal undertakings.

A great readjustment of all business affairs must come at the close of the war and this will cause a serious depression in many lines of business. Many soldiers will return to civil life only to find their old places filled or abolished. Distressing conditions are likely to exist which will call for a wide distribution of charity unless great public works construction programs are all ready to launch.

England and France know these things and are preparing for peace. Can we learn from England and France?

That Word "Municipal"

The word **municipal**, as it is used in the title of this publication, should be broadly interpreted or it is quite misleading. Latterly, usage has tended to restrict the application of this word to the city, whereas pure diction still applies the word not only to the city but to the state, the county and the township. As we use it, it has the latter significance and we desire to place emphasis on that fact.

Those who read the publication carefully can be depended upon to appreciate the breadth of its field. They know that country roads, for example, are regularly treated from the engineering standpoint. The problems of the state and county engineer are given proper attention. With this issue we begin the publication of a drainage and irrigation section. These are not **city** activities, as we shall handle them, but they are **municipal** activities in the sense that they are largely planned by public officials and paid for out of public funds. Since we treat of such projects as are paid for by public funds there is no good reason why exactly similar projects, from the engineering standpoint, paid for by private funds should not also be described in this publication, so the breadth of our field is great.

While on the subject of our title let us emphasize, also, that this is an engineering publication. This is not a civic journal, an uplift organ, or the official organ of ladies auxiliaries of ward improvement associations.

Those who would understand the scope of this publication need do not more than read our subtitle: The Design, Construction, Operation and Maintenance of All Public Works.

A Labor Fallacy

Authorities at Washington are somewhat complacent, admittedly, about throwing some men out of their accustomed employment, because of the fact that men are needed in other lines more directly connected with the prosecution of the war. Apparently it is the assumption that if a man loses one job he will unerringly and speedily secure another in a line considered more essential during the emergency.

While there is undoubtedly a theoretical tendency in the direction the officials seem to have in mind the actual reapplication of labor is difficult and in some cases virtually impossible.

On public works construction in Chicago, for example, the laborers are not young men of the best military age. In fact, the majority of these men are above military age and would not enter the army even if unemployed, moreover, they have grown old in this form of public service and know little else. They would not be efficient on any other kind of work.

To stop public works construction in Chicago would undoubtedly throw out of employment thousands of men who would remain idle until this work was resumed. These men would no more go to the coast cities to work in ship-building or munitions plants than they would go to Mars to extend that planet's irrigation system.

Buy Motor Trucks Now

Contractors and others who are a long time making up their minds whether they want to purchase motor trucks or not, may find, when they finally do decide to buy, that they will have a long wait for deliveries. The demand for trucks is now great and is increasing, so contractors should place their orders now for immediate or spring delivery.

Contractors are not strangers to the hazards of business, and ordinarily are willing to assume risks. It is true there is a reasonable doubt about the volume of work, in some lines, for contractors the coming season, but their is small doubt there will be extensive construction of interstate and intercity hard roads. The contractor can afford to assume that there will be a good volume of road work. The best information obtainable, as well as a study of the European precedents, indicates the raising of the embargo on the shipment of road-making materials and an increasing volume of road construction. Trucks will be used more than ever this season on road construction, so contractors should get in their orders now.

Arthur Brisbane, the able and influential editor, is advocating a short-haul railway embargo, to compel the use of motor trucks on short hauls thereby leaving the railways free to handle long hauls. The arrangement advocated would save shippers much demurrage due to the bad habit of slow unloading of freight cars. Small freight shipments for short hauls tie up freight cars and cut down the efficiency of such cars. Brisbane's suggestion may not be formally adopted officially, but it will very likely be urged officially and voluntarily adopted by shippers. This will greatly increase the demand for trucks.

Motor freight haulage is gaining enthusiastic support on all sides daily. The advantages of such transportation are becoming better understood. There are several motor truck routes in successful operation, and they are being well advertised. With trucks the load goes from point of origin to point of delivery direct, while with rail shipments the load must be handled four times instead of twice. This not only saves transfer charges, but saves time, and relieves railway car shortage and congestion. Some observers say that trucks will soon be employed to haul the bulk of freight shipped short distances, say up to 75 or even 100 miles. Think what a demand this will make for trucks!

The government is purchasing thousands of motor trucks and will doubtless continue a big buyer of trucks as long as the war lasts. All lines of business are motorizing their haulage and delivery departments more rapidly and more extensively than ever before.

For the various reasons enumerated, the demand for trucks is increasing daily, with no let-up in sight, so contractors should place their orders now.

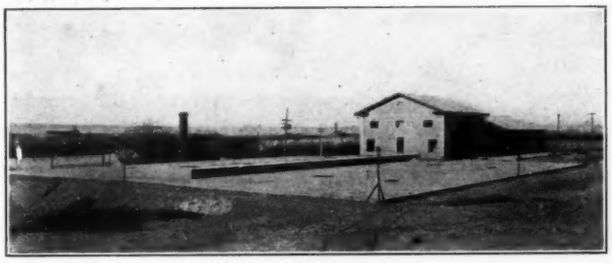
Design and Construction of the Water Purification and Softening Plant at Great Falls, Montana.

By Robert E. McDonnell, of Burns & McDonnell, Consulting Engineers, Interstate Building, Kansas City, Mo.

GREAT FALLS, MONT., with a population of about 30,000, has for years used the Missouri river water in its raw state for both domestic and fire uses. An agitation for a pure water supply has extended over a period of about ten years, the agitation being due to the fact that the water was very turbid at certain seasons of the year and that typhoid cases in the city were also above normal. About two years ago the State Board of Health of Montana took an active interest in the health conditions of the city, believing that much of the typhoid of the city was undoubtedly due to using the Missouri river water without adequate purification.

Women Demanded Soft Water

One bond issue had previously been defeated for the installation of a filtration plant, but the defeat was attributed largely to the fact that information concerning the beneficial results of filtration and the cost of purifying water was not clearly and fully presented to the citizens. To avoid the mistakes made formerly the citizens undertook to inform themselves thoroughly as to the value of pure water, cost of filtration, beneficial results of filtered water, and a campaign of education was conducted largely through the influence of the Commercial Club, Rotary Club, Women's clubs and other civic organizations. At one stage of the discussion it was found that the women voters of the city would be against the bond issue for filtration unless it also included water softening, so to insure the success of the bond issue the plans were therefore made to provide for a combined water softening and purifying plant. Although the water is not an unreasonably hard water, the desirability for a softer water was felt by the women voters.



GENERAL VIEW OF SETTLING BASINS, RAISED MIXING CHAMBER, CHEMICAL HOUSE AND FILTER HOUSE, GREAT FALLS, MONTANA, WATER PURIFYING AND SOFTENING PLANT.

After bonds had been voted for the project, the engineers employed by the city, Burns & McDonnell, Kansas City, Mo., were instructed to prepare their plans and specifications to cover both water softening and purification. A citizens' committee was appointed outside of the City Council to take charge of the execution of the work, and this citizens' committee, which was composed of the leading citizens and several local engineers, passed upon the plans, specifications, receiving of bids, final tests and other details of the entire work.

Design of Plant

The improvements consist of an electrically-operated low-service pumping station, which takes water direct from the Missouri river and discharges it into a mixing chamber, where the chemicals are thoroughly mixed with the water previous to its passing into the settling basins. After passing through the settling basins the water then flows into eight 1,500,000-gal. filter units, thence into the clear water reservoir.

The electrical pumping station equipment consists of four motor-driven centrifugal pumps—two 2,000,000-gal. pumps and two 4,000,000-gal. pumps, or a total of 12,000,000 gal. pumping capacity.

The purification plant consists of, first, a reinforced concrete mixing chamber. Owing to the softening requirements the mixing chamber was designed with a view of a thorough mix and a long travel of the water before passing into the settling basins. To insure the water passing through the mixing chamber and to overcome the loss in friction through baffle walls, the mixing chamber stands at a level about 3 ft. higher than the settling basins. The travel through mixing chamber is 1,160 ft., requiring a time in the mixing chamber of 36 minutes when pumping at the rate of 12,000,000 gal. per day. When pumping at a higher or lower rate the length of travel and velocity through the mixing chamber can be maintained at various rates by changing the baffle walls or cutting out a portion of the mixing chamber. The velocity through the mixing chamber of .77 ft. per second prevents any sediment depositing in the mixing chamber.

Amount of Chemicals Used

The thorough mixing that is given in the mixing chamber accomplishes considerable clarification before the water even reaches the end of the mixing chamber, and it therefore passes into the settling basin with this clarification process well started. The water has a retention period in the settling basins of about 8 hours when filtering at the rate of 12,000,000 gal. per day; the water, therefore, reaches the filters in a well-prepared condition for filtration. An examination of the residue in the bottom of the settling basins does not show any undissolved or unused chemicals, and experiments were conducted for about 30 days to determine the minimum amount of chemicals that could be used to obtain the most efficient results. It was found that from .6 to .7 grains of sulphate of iron was the amount of chemical required for thorough sedimentation during ordinary stages of the water. This quantity will undoubtedly have to be increased during the highest turbidity stages of the water. Although the natural lime in the water is small, yet with the thorough mixing accomplished in the mixing chamber it was found that it was not necessary to add lime to the water, and the omission of lime is a large saving in the annual cost of operation. This saving in lime is undoubtedly accomplished by the thorough mixing the water receives in the mixing chamber.

Chemicals for both water purifying and softening are fed by dry-feed machines, and are connected with a Venturi meter and so arranged that the chemicals fed are in direct proportion to the water used. It is believed that this saves greatly in the amount of chemicals used, as well as in getting a uniform strength of solution.

At Great Falls, as in many other cities, the volume of water pumped during the 24-hour period varies greatly at different portions of the day. The water consumption at Great Falls will vary from 2,000,000 to 12,000,000 gal. per day, and the dry-feed machines automatically control the chemicals, thus having the proper amount of chemicals for the water used.

The chemicals for the plant are purchased in carload lots and hoisted by electric elevator to the fourth floor of the chemical house, where the chemicals are placed on top of concrete hoppers which lead to the hopper of the dry-feed machines on the floor below.

The Filters

The filters are arranged in eight units, four on each side of the main filter floor, partially exposed so that the water can be observed. The filter units are of 1,500,000-gal. capacity each, and cleaning is accomplished through the use of air and water and all valves used for cleaning and controlling are electrically operated. The operating tables are of marble construction. The loss of head gages, sampling devices, clock and all equipment is of nickel-plated finish. The loss of head gages are of the recording type, which both indicate and record the loss of head consumed in the operation of the filter and indicate the time when the filter requires washing. Each loss of head gage is equipped with three indicating pointers, the first indicating the water level in the filter, the second indicating the wash water pressure, and the third indicating the loss of head in the filter. The recording chart is rectilinear in form, graduated horizontally in hours and vertically in feet, and so arranged that each will give record for 24-hour run of the filter. The rate of filtration in each filter is controlled by an outlet

EXTERIOR VIEW REINFORCED CONCRETE LOW SERVICE PUMP STATION, GREAT FALLS, MONTANA, WATER PURIFYING AND SOFTENING PLANT.

controller in the effluent pipe. By means of a graduated handwheel located on the operating floor the rate controllers may be set to give any desired rate of filtration between the limits of zero and 2,000,000 gal. per day for each filter.

Filter Plant Accessories

The pipe gallery beneath the main filter floor is well lighted and has sufficient space and head room to make it easily accessible for observation or repairs.

The motor-driven air blower has a capacity of 2,600 cu. ft. of free air per minute at 4 lbs. pressure, and is operated by a 50-h.p. squirrel cage electric motor. The blower is of the Root type and has a capacity and pressure sufficient to give a uniform agitation of sand by the air.

A part of the equipment is a 24-in. Venturi meter recording the rate of flow in gallons per day, with a chart recorder giving an unbroken autographic record of the rate of flow from hour to hour, and a counter-dial showing the total gallons of water that have passed through the meter. These features, while not absolutely essential in any water works plant, are considered desirable for an efficient and intelligent operation of any modern water works plant.

Removal of Bacteria

The guaranteed bacterial efficiency of 97 per cent. was exceeded considerably in the tests which were conducted for about 30 days, the filtered water being clear and sparkling and free from suspended matter, odors, turbidity and discoloration. In a series of tests the bacterial efficiency for each filter was as follows:

Raw water from river	1,480	bacteria	per c.c.
Water in settling basins	910	"	"
Water from Filter No. 1	8	"	"
Water from Filter No. 2	14	"	"
Water from Filter No. 3	6	"	"
Water from Filter No. 4	6	"	"
Water from Filter No. 5	4	"	"
Water from Filter No. 6	8	"	"
Water from Filter No, 7	2	"	"
Water from Filter No. 8	8	"	"
Average of the eight filters	7	"	"

Efficiency of filters, or average bacteria removal from water, 99.52 per cent.

Efficiency of settling basins, or bacteria removal from settling basins alone, 38.5 per cent.

No liquid chlorine was used in this test.

In Filter No. 2, which shows 14 bacteria per c.c., this sample of water was collected immediately after washing Filter No. 2.

Chlorination

The entire plant is provided with liquid chlorine equipment as an adjunct to the filter plant, but not as a substitute for filtration, for it is a well-recognized fact that liquid chlorine does not make a dirty water clean, and it should be used as a sterilizer for emergency purposes rather than depended upon as a means of purification.

One noticeable result since the plant has been placed in operation is the decline in the sale of bottled water, for analyses have shown that the municipal supply is far superior to most of the bottled, including spring and distilled, waters on the market.

Settling Basins and Clear Water Reservoir

The settling basins are 18 ft. deep, 160 ft. wide and 180 ft. long, having reinforced concrete slab covers. The floors consist of two layers of concrete with waterproofing between the joints. Two reinforced concrete 6-in. baffle walls extend the full length of the basins. The basins are divided into two chambers, so that when one is undergoing cleaning or repairs the other may be used. The mixing chamber is also divided into two chambers, so that one half may be used while the other is being cleaned or repaired. The outside of the settling basin is of the buttress type, reinforced, but with the excavated earth filled to the top of the basins.

Beneath the filter house is the clear water reservoir, also of reinforced concrete construction. This has a depth of 9 ft., and the water flows from this clear water reservoir by gravity to the suction of the high-duty pumps. The location of the plant on a hillside gives 12 ft. head to the suction of the high-duty pumps. All the piping from the pump station to the purification plant passes through a 6-ft. by 8-ft. reinforced concrete tunnel under the Great Northern Railroad tracks.

Filter Buildings, Etc.

The filter house, chemical house and head house are of brick construction, using buff-colored pressed brick exterior, with steel roof trusses, and large windows of the "Fenestra" sash type. Considerable ornamentation was given to the exterior and interior of the filter house building, with the idea in view that the plant will be visited and inspected not only by the citizens of Great Falls, but by many representatives of other municipalities.

Inspecting the Plant

It is taken for granted that the average layman is not thoroughly familiar with the process used in water purifying and softening, and it is believed that better results in cities can be accomplished by making the water users familiar with the care with which their water is treated and handled. Inspections of the plant are invited. During the first month's operation of the plant at Great Falls representatives from about

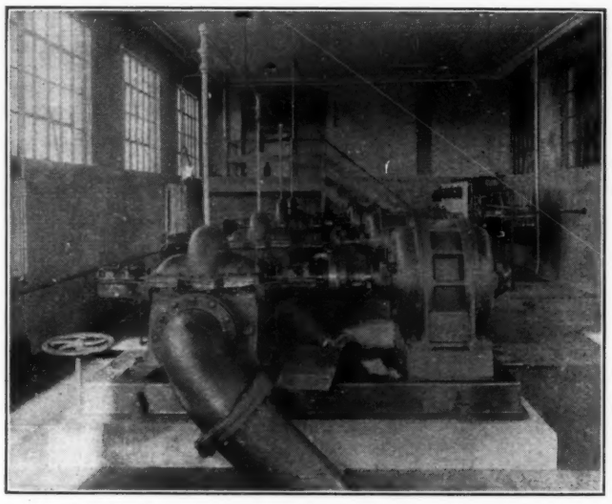
fifty municipalities inspected the plant and its operation, and it is believed that such inspections greatly aid in the general education of the public to realize the value of pure water and how it can be obtained.

A complete softening of the water is not attempted, as the water is not an unusually hard water, but a partial softening is accomplished at reasonable expense, the soda ash for softening being also fed by a dry-feed machine and into the mixing chamber along with the sulphate of iron and lime.

It is believed that the installation at Great Falls embodies all of the modern features of water softening and purifying plants to make it not only efficient in results, but economical in operation.

Meterage Follows Filtration

Great Falls, like many Western and Northwestern cities, has used water at flat rates, but with the installation of the purification plant it is realized that it is poor business policy to filter water for irrigating use for parks, lawns and war gardens; therefore, the officials are taking the preliminary steps toward placing all water users on a meter basis. The water



INTERIOR OF LOW SERVICE PUMP STATION, GREAT FALLS, MONTANA, WATER PURIFYING AND SOFTENING PLANT.

consumption at Great Falls at the present time is reported to be highest of any city in the United States, being approximately 400 gal. per capita per day. The use of meters was not considered while raw and highly turbid water was being used, but now, with a clear, sparkling water, no objection can be urged against the use of meters.

The entire grounds surrounding the filtration plant, consisting of about ten acres, is being beautified by the Park Board by building of roads, paths, lawns and shrubbery, as well as ornamental lighting, in the belief that efforts to supply good, clear, pure water should be supplemented by making the building and grounds equally clean and attractive.

With the installation of meters it is believed that the present water purifying and softening plant is sufficient to take care of a population of approximately 100,000.

A new 48-in. flow line to the suction of the pumps is now being installed and other improvements in reinforcing the distribution system are in progress. The entire distribution system in the city is of cast iron and consists of about forty-five miles of pipe. The water is delivered into the mains under direct pressure by five motor-driven high-service centrifugal pumps.

The above work was let by competitive bidding and was subdivided into three sections. The total cost, including engineering, real estate and incidentals, was approximately $225,000.

Personnel

Olson & Johnson, of Missoula, Mont., were the contractors who installed the settling basins, filter house and the general construction work. The low-service pump installation, including all piping, was installed by the Merkle Machinery Company, and consisted of Platt Iron Works pumps and General Electric Company motors. The water softening and purifying plant was installed by the Pittsburgh Filter Manufacturing Company, of Pittsburgh, Pa. M. L. Morris, who supervised the installation of the work, has been appointed by the city as superintendent of filtration, and has full charge of the operation of the plant. The plans, specifications, supervision of construction and final tests were conducted by Burns & McDonnell, consulting engineers, Interstate Building, Kansas City, Missouri.

Procedure in the Maintenance of Automatic Sewage Siphons and Ejectors

Apparatus usually receives, at the hands of the designer, considerable thought and study in standard construction and standard uses; also, in special uses a further amount of study is required to adapt standard equipment to the purposes intended. Such study and research varies in direct proportion to the personal equation of the manufacturer. It can be stated, however, as quite a matter of fact, that no apparatus is offered for sale or installation for any unsuitable use, if the manufacturer is fully advised in advance.

It is obvious, therefore, that all parties contemplating the use of automatic equipment, such as sewage disposal apparatus, ejectors, etc., should avail themselves not only of the literature the manufacturer prints, but the personal services of the same manufacturer in an advisory capacity, before such equipment is ordered through the contractor.

Precautions in Design and Installation

In designing plants requiring apparatus, full consideration should be given for growth in volumes of sewage to be handled and the character of the sewage, in order that the apparatus may be adequate in size to perform the duty required, and in many instances, particularly in ejectors, duplicate installations, each equal to the maximum requirement, should be installed.

In installing apparatus of this character the municipalities should employ the manufacturer to exercise a certain amount of supervision, as may be required, to see that the work is performed in such a manner that the apparatus will satisfactorily operate and continue to operate.

The municipalities should require full sets of assembly drawings of all such apparatus, and, before the contractor is discharged and the apparatus accepted, the mechanic to be placed in charge of the plant should be carefully instructed in the use of the apparatus.

Specific Suggestions on Maintenance

In the maintenance of such plants the municipalities are under the disadvantage of frequently changing their employes, and it must be obvious that an unskilled operator may not be able to secure from any apparatus the results obtained by his predecessor, who was able to operate the plant and understood thoroughly the basic principles of the machinery.

A record should be kept at the plant of the performance of the apparatus, the same requiring little or no attention, except possibly after a very heavy storm in plants where the sewer systems tributary are combined and not separate.

All moving parts apparatus requires considerable attention at the place of wear, and non-moving apparatus requires occasional cleaning.

Pits and pockets containing apparatus are likely to sludge up, and should be pumped out and kept clean at the bottom, at comparatively regular intervals.

Plants should be more or less protected from loose leaves, sticks, and rubbish generally, which may be thrown into the pits, and this is accomplished by covers over the apparatus, with open joints for ventilation.

Plants that are exposed to freezing in very cold exposures should be protected during the winter months.

It would be wise for each municipality to employ the original designing engineer to inspect its plant at intervals of, say, once in sixty days for large plants, and possibly once in six months for smaller plants. The expense for such inspection would be well justified, as errors in operation would be corrected and results obtained continuously for which the plant was originally designed.

The manufacturer of the apparatus furnished and installed could properly be employed in the larger plants to make examinations, rather than to permit an unskilled operator to conduct his own experiments, or to alter the apparatus without consulting the manufacturer.

In a general way the simpler the apparatus is, the more readily it is comprehended by the average caretaker, and the more reliable the manufacturer is, the more serviceable the apparatus will be.

Summary

In summarizing, it would appear to be very essential that maximum volumetric conditions be thoroughly taken care of in the original design; that loss of head necessary for successful operation be also thoroughly understood and arranged for; and, further, that the apparatus itself be observed at regular intervals, and all chambers containing the same be protected from rubbish of all sorts, and frost, and kept clean, so that the equipment may not fail.

All hydraulic apparatus requires to be installed in watertight compartments, and the outfalls from the plant must be able to take off the sewage at the maximum rate, and the outlets remain free at every point.

Municipalities owning sewage disposal plants should not hesitate to communicate with the manufacturers of all such apparatus, providing themselves with proper assembly drawings and literature pertaining to the special apparatus furnished, and its engineering department should be familiar with these also.

Imperative Need of the Lakes to the Gulf Deep Waterway

By H. B. Morgan, General Manager, Peoria Water Works Co., Peoria, Ill.

We have to the north of us a chain of lakes with more than 4,600 miles of shore. We have to the south of us the Father of Waters, the Mississippi River, which, together with its tributaries comprises more than 16,000 miles of navigable waterways. There never has been a waterway improvement in all the history of the world where the possibilities were as great or where the results, when finished, will be of greater advantage to as great a number of people, as to connect the Great Lakes with the Mississippi and the Gulf of Mexico, said Mr. Morgan in addressing the Illinois Section of the American Water Works Association.

Compared with Suez and Panama Canals

The Suez canal was a wonderful undertaking, and has been productive of great good. The construction of the Panama Canal—the wonder of the world——was a stupendous task that cost millions upon millions of dollars, and it is bound to be of great benefit to the water transportation of the world. Both of these canals put together are not of as great importance to the people of this country and to the people of the world, which we must help to feed, as connecting the Great Lakes with the Mississippi River and the improvement of all its tributaries.

Right here, I ask you to stop and consider what it would mean to this country at this time of war preparation, and the heavy, urgent demand for food and other supplies for our soldier boys at the front and in the camp, as well as for the soldiers of our allies, if this chain of Lakes and these magnificent rivers were connected with adequate waterways.

Illinois River a Fine Stream.

Did you know that, for its length, the Illinois River is the peer of any river in this country, if not in the world? The channel rarely ever changes. The pilot who "ran the stream" a quarter of a century ago would have no difficulty in taking a boat from La Salle to Grafton, although he may not have been over the stream in the meantime. At least, this is the testimony of the old time pilots themselves.

The distance, by river, from La Salle to Grafton is about 230 miles, with an average declivity of only 1½ ins. to the mile. The stream today has a minimum depth of 7 ft. and to make it a deep waterway it would only be necessary to dredge soft mud from its bottom, and remove the two state dams and the two Government dams. Since the opening of the Chicago Drainage Canal, with a portion of the waters of Lake Michigan flowing down this way, these dams are an obstruction rather than a benefit to navigation.

Need of Lakes to Gulf Waterway Long Recognized

For almost two and a half centuries, ever since Joliet and Marquette, in 1673, crossed the divide from the Des Plaines River to Lake Michigan, on their return from the Mississippi River to Green Bay, the need of a waterway through the divide has been felt.

In 1819, the St. Louis Enquirer said: "The communication between Lake Michigan and the Illinois River is a point which will fix the attention of the merchant and the statesman. They will see in it the gate which will open the northern seas into the valley of the Mississippi, and which is to connect New York and New Orleans by a water line which the combined navies of the world cannot shut off. Never did the work of nature require so little from the hand of art to complete so great a design."

For years and years the question of a better and bigger canal from the lakes to the Illinois River, one that would accommodate modern steam propelled craft, has been agitated. And since the opening of the Chicago sanitary drainage canal, the need of the improvement has been felt more than ever before.

The Mississippi Below Cairo

By far, the biggest problem to be solved, in constructing a deep waterway from the Lakes to the Gulf is that portion of the Mississippi River below Cairo. There the channel of the River is ever changing, owing to the wash of the banks, which are made up of soft alluvial earth. It has been estimated, that the amount of sediment carried down the Mississippi and emptied into the Gulf of Mexico every year is almost, if not quite equal to a cubic mile.

For upwards of 60 years, the General Government has been striving to find some way by which the channel may be controlled, and millions upon millions of dollars have been expended in experimenting along these lines, with little, if any, permanent benefit.

Let us hope that some way will be found to solve the problem, and that a great waterway will eventually be constructed down there, to the end that boats of large tonnage may pass unobstructed from the gulf to the lakes.

When this result is accomplished we of the Mississippi and Illinois valley will be able to transport freight from and to the Pacific coast in competition with New York and other Atlantic coast points.

Cheapness of Water Transportation.

In the past Peoria has shipped certain class freight by rail

to the Atlantic Coast, there transfer it to ships which took it through the Panama Canal, up the western coast to San Francisco and other points on the western coast, for a less rate than could be had by all rail route to the same points. The all water rate from New York to San Francisco is about half of the all rail rate from Chicago and Peoria, to the same place.

How long do you think we can stand this and remain on the map commercially?

When we stop and consider that 24 ft. of water can be had from the Gulf of Mexico to the Gulf of St. Lawrence, a distance of 3,300 miles, for less than the cost of the Panama Canal, and that the value of the Panama Canal to this country is a mere bagatelle when compared to the 24 ft. waterway, then it is that we wonder why our government has not long ago developed this waterway.

Comparison of Water and Rail Rates.

Several years ago Major Riche of the Army Engineer Corps, in a report to the War Department, supplied the following figures, as a comparison between the rates from St. Louis to St. Paul, 573 miles by rail, 729 miles by river, and the rates from St. Louis to Oklahoma City, 543 miles by rail, with no water competition:

Rail rate to St. Paul, first class	.63
River rate to St. Paul, first class	.40
Rail rate to Oklahoma City, first class	1.30

The rail rate to Oklahoma City, with no water competition, for virtually the same distance, is approximately twice that along the route where there is water competition.

Major Riche then goes on to say: "While it is not claimed that river improvements are solely responsible for the great difference in freight rates above shown, it is well known that where ever water competition exists, whether by river, canal or lake, its effect on freight rates is always beneficial to the public, and so long as the navigation is practicable, and somewhat in proportion to the feasibility of that navigation, such benefits will accrue even if but little river commerce is actually carried on."

Conclusion.

Failure to improve our waterways will work disaster, not only to cities in the interior, but to those on the coast as well. The prosperity of port cities, and of the railways by which they are served, depends upon the prosperity of the territory tributary thereto.

Our waterways are of vital importance to our national interests, whether in time of peace or in time of war, and nothing whatever should be allowed to prevent or delay their improvement.

Commercial supremacy is based upon industrial development; industrial development depends upon economy of transportation, and the cheapest of all transportation is water transportation.

PAVEMENT DESIGN AND CONSTRUCTION

Asphaltic Macadam Road Building in the Michigan Copper Range

By C. C. Lakin, 72 W. Adams St., Chicago, Ill.

Houghton county, Michigan, in the heart of the copper country, has many miles of good roads and is adding more each year. The Dollar Bay road, built during 1917, is typical of construction methods used on most all of their roads.

The Houghton County Commission do most of the work with their own organization under the direction of Mr. Randolph Martin, County Engineer, and his assistant Mr. Thomas Coons.

The stone used in road building is crushed with their own equipment from tailing piles from the copper mines, and delivered to the different locations in the county over railroads, and is in most cases dumped in bins from which wagons are loaded with little labor.

Following is a description of the methods, followed in constructing the Dollar Bay Road:

Grading

The roadway was graded to a width of 16 ft. and cut and fill made to bring the sub grade to 7½ ins. below and parallel to the finished surface of the pavement. The crown was carried at 2½ to 3 ins., a 3 ft. shoulder was made on each side of the roadway, drainage ditches excavated at both sides of road and culverts built across the roadway where necessary. As the roadway was brought to grade it was thoroughly rolled with a 10-ton roller.

Base Stone

The base stone, ranging in sizes from 4 in. to 2½ ins. was then spread on the prepared roadway, at the rate of 6 sq. yds. to the cubic yd. This stone was then thoroughly rolled with a 10-ton roller. On this was then spread screenings and chips at the rate of 25 sq. yds to the cubic yard, and thoroughly rolled. It was then ready for the 2½ in. pouring course stone.

Key Stone

The key stone and top dressing chips were delivered at the side of road as the placing and completion of the base or foundation progressed, being deposited in certain sized piles, certain distances apart as called for, to secure a uniform spreading of 60 and 70 sq. yds. to the cubic yard, respectively.

Pouring Course

The stone used in pouring course was graded from 2½ to 1¼ ins. and was dumped and strung on the roadway about 3 ft. from the side at the rate of 16 sq. yds. to the cubic yard, hauling 2 cu. yds. to the load. A 4-wheeled 2-horse road grader was used to spread the stone over the roadway. This was accomplished to a fairly uniform thickness and was brought to perfect grade by a little hand trimming by men with rakes and shovels. The course was then rolled with a 10-ton roller, going over the surface twice, care being taken not to pack or crush stone by excessive rolling. After the rolling, the surface was gone over and any low places raised with more stone and tight or close places loosened up to permit of free penetration of the asphalt. The course was then ready for the asphalt.

Application of Asphalt

The Stanolind Paving Asphalt was applied at a temperature of 300°F, under 45 lbs. pressure. The tank wagon used was furnished by the Standard Oil Company being equipped with a compressor, large fire box, and all the necessary appurtenances for the unloading from tank cars, as well as applying it on the road. On the Dollar Bay road the tank wagon was hauled to and from the tank car, a distance from the work of about one mile, by four horses.

When the tank wagon reached the work it was pulled

over the roadway by the steam roller which also furnished the steam to run the air compressor attached to the tank. The first application of asphalt was made at the rate of 1½ gals. to the square yard. The spreading of the ⅞ to ½ in. key stone followed, and was uniformly spread at the rate of 60 sq. yds. to a cubic yard.

When the tank was emptied it was turned around and pulled back over the key stone to where the road was completed, and taken back to the tank car by horses. The roller then thoroughly rolled the key stone course and any excessive amount of key stone was broomed off.

The next tank load completed the above portion by the application of ½ gal. Stanolind Paving Asphalt to the square yard, and also continued applying the 1½ gal. application on the first or pouring course ahead.

VIEWS ON THE CONSTRUCTION OF THE ASPHALTIC MACADAM DOLLAR BAY ROAD, HOUGHTON COUNTY, MICH. Top Row (Left to Right): Subgrade made and Shoulder Constructed, Roadway Ready for Foundation Stone—Placing Base Stone at Rate of 6 Sq. Yds. to 1 Cu. Yd.—Base Stone Rolled and Ready for Fine Stone Filler. Bottom Row: Filler Stone Spread and Rolled in Base Stone; Pouring Stone strung Along Sides to be Spread with Road Grader—Application of Stanolind Paving Asphalt to Pouring Stones at Rate of 1½ Gals. to Square Yard—Completed Roadway Opened and Used as Fast as Top Dressing was Spread and Rolled.

The one-half gallon application was followed as closely as possible by the spreading of the top dressing stone chips ranging in size from ⅝ to ¼ in. free from dust and spread at the rate of about 70 sq. yds to a cubic yard. This was thoroughly rolled and opened to traffic as fast as finished.

Quantities

Each day's work was brought to as nearly a completed condition as possible. The work progressed at the rate of about 730 ft. or 1,300 sq. yds of completed road each day.

The completed pavement averaged 8 ins. thick and required about 790 lbs. of stone, and 2 gals. Stanolind Paving Asphalt "C" to the square yard, making the average weight of the pavement 807 lbs. to the square yard or about 100 lbs. to each inch in depth to the square yard.

The accompanying photographs show the different stages of the work from the grading to the finished roadway.

Using Stone Crushing Outfits to Utilize Street and Road By-products

In New England many of the municipalities and leading contractors are installing stone-crushing outfits to utilize by-products of the streets and roads, such as brick, cobble stone, broken concrete, worn out curbing, and paving blocks, and find that the practice pays. One day recently a dozen Mayors, representing as many Connecticut Cities, met by appointment in Meridian, Conn., to witness a practical demonstration of a gasoline driven machine combining the functions of a street sprinkler, sweeper and dust gatherer. The machine did perfect work at the speed of 18 miles per hour. Several municipalities in New England, notably Worcester and North Adams, Mass., are puting their crushing plants into their gravel banks and running all raw materials into the crusher.

Basic Principles of Design, Construction, Maintenance and Financing of Roads and Pavements

By J. W. Howard, C. E., E. M. Consulting and Testing Engineer of Roads and Pavements, New York City.

It is wise for city, county, state officials and engineers connected with making plans and specifications for roads and pavements and supervising their construction and maintenance, as well as the public which uses them and pays their cost, to remember certain basic principles which are essential for the construction of good and efficient roads and pavements, and their continuous economic maintenance in good viable condition thereafter.

All roads and pavements, which are finally economic, in regard to the cost of first construction together with the subsequent, eventual necessary maintenance in proper, constant good condition for many years and indefinitely, consist of three distinct parts:

Three Parts of a Road

First—A SUBSOIL, well drained and firmly consolidated.

Second—A FOUNDATION or permanent base of portland cement concrete or of any well established other durable material, such as firm telford; thick consolidated macadam; old worn but solid brick, stone or other blocks properly evened up with a dense water proof asphalt concrete (called "close binder") and thus remade into good foundations.

Third—A WEARING SURFACE LAYER of substantial thickness, to be reasonably durable and designed to enable it to be eventually maintained in constant good condition at the lowest possible annual cost; there being no permanent roads and pavements because all must be constantly maintained.

Pavement Economics

The various materials for foundations have their proper places as well as those for wearing surface layers such as, sheet asphalt, asphalt-concretes of various types, bricks, stone and other blocks, bitumen and water bound macadams, etc.; depending upon local conditions, climate and traffic to be expected, flat or undulating grades, kinds of adjacent property, uses of the road or pavement, etc.; also upon available ma-

terials of construction and the cost of materials and labor. The cost of street cleaning must be kept in mind; also the cost of traction by horse and motor over different kinds of surfaces; and the ease and speed of traffic and beauty of the surface. All are inter-related with the cost of first construction and interest upon it and the cost of continuous maintenance. Periodic repairs are to be avoided, but if made they are a part of maintenance. Constant maintenance is cheapest and best on the principle that "a stitch in time saves nine" and enables a road or pavement constantly to fulfill its proper function of facilitating transportation of light and heavy loads of persons and goods, agreeably, rapidly, safely and economically as modern requirements demand.

Maintenance Most Important

It is well to be guided by the long established policy of the *Ponts et Chaussees* (Bridges and Roads) Department of France, whose Engineers have charge of all roads of France and pavements of its cities, that "Economic, constant maintenance and not low first cost is the truest economy for bridges, roads and pavements." This is because maintenance, including, at long intervals, general repairing or resurfacing, must be paid for from current public direct or indirect taxes, continues for ever, and therefore constitutes the real cost to the people. Maintenance in time becomes a much greater total cost than the first cost of any kind of road or pavement which includes its subsoil preparation, foundation and surface layer. Maintenance is applied generally only to the surface layer; the subsoil preparation and foundation being a permanent investment and should need no maintenance. The types of wearing surface layers which can be repaired and maintained by small additions at short intervals are generally in the end cheaper than the types which must have the entire surface layers replaced at short or even long intervals. Types of wearing surface layers which can be constantly repaired, do not obstruct traffic when prompt repairs are made to worn or injured spots or areas.

Financing

The problems of financing, constructing and maintaining roads and pavements are closely interdependent and require the services of properly qualified experienced engineers. These matters should not be undertaken by the legislative and administrative officials nor by laymen and citizens, without reliable expert engineers, any more than the matters of sanitary sewers, water supply systems and other public works.

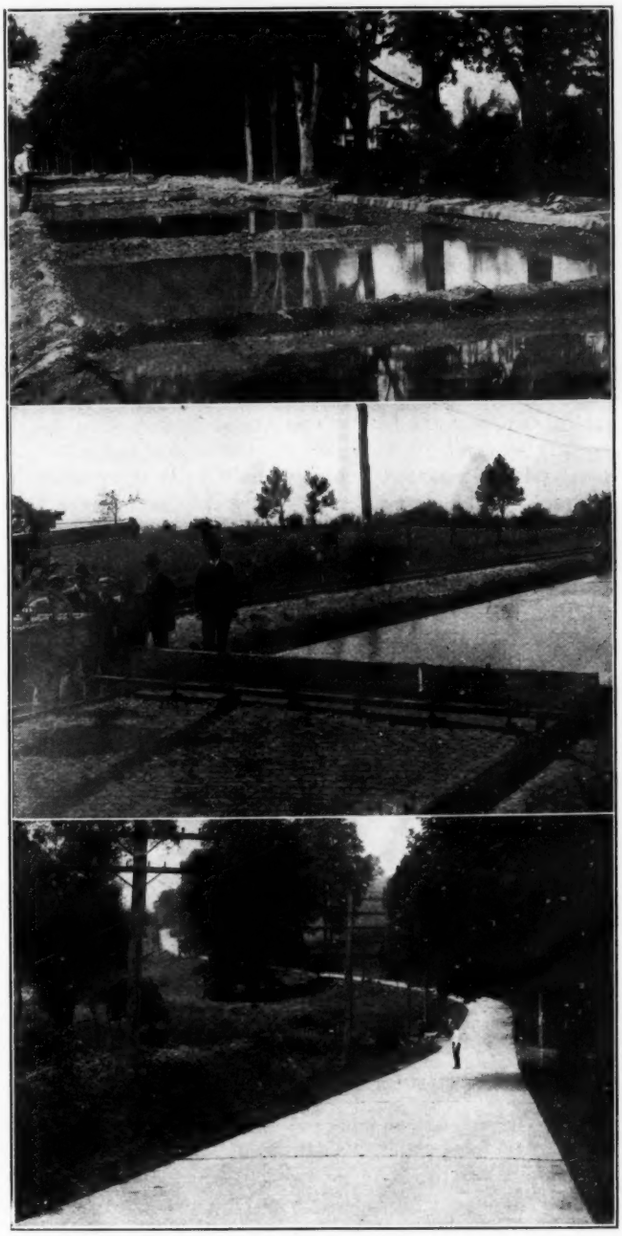
The original capital from bonds or assessments, invested in the three stated parts which constitute the whole road or pavement from bottom to top, will always be on hand, provided current good maintenance is paid from current income. This current income comes from taxes, automobile and other sources benefitted by good roads and pavements; which means from almost every body, because transportation serves all of us.

The many millions spent in the past and more than $400,000,000 now being spent annually for new roads and pavements in the U. S., makes the problem of economic maintenance the vital one. Without economical, good maintenance we will lose many millions of investment and many roads and pavements now built and be unable to add much more mileage to that we now have.

Drainage, subsoil preparation, foundations and wearing surface layers of roads and pavements are each separate important subjects which must be carefully studied. Each is a subject upon which much information exists and many separate useful articles can be written.

Reinforcement for Concrete Pavements

In the search for the ideal pavement practically all the materials of construction have been tried. While concrete has been used for years as the base or foundation for pavements, having some sort of brick, block or asphaltic wearing surface, it is only within a comparatively short time that this material has been used throughout in the construction of roads and street pavements.



UPPER—CURING CONCRETE PAVEMENT BY PONDING, BELLEVUE AVE., HAMMONTON, N. J.
MIDDLE—SETTING KAHN ARMOR PLATE IN PROPER POSITION BY USE OF INSTALLING DEVICE.
LOWER—VIEW ON BALTIMORE PIKE, A 22-MILE CONCRETE ROAD, NEAR WAWA, PA.

Recent years, however, have shown that the all-concrete pavement laid in either one or two courses gives very satisfactory results. The enormous growth in the yardage of concrete roads and pavements laid during 1915 and 1916 is directly traceable to the fact that concrete pavements have at last come to be considered as one of the reliable standard pavements and not a cheap, makeshift temporary surfacing. With this change in viewpoint has come better engineering;

better and more careful study of local conditions; more carefully drawn specifications, and last, and most important of all, the more careful and conscientious contractor.

Early Concrete Roads

The history of the concrete pavement previous to 1906 is practically a story of occasional effort on the part of more or less daring individuals to make concrete, an important part of all other standard pavements, become the complete pavement in itself. One interesting example of an experimental concrete pavement to which reference is now being continually made is that at Bellefontaine, Ohio. In 1893 and 1894 the streets surrounding the Court House in that city were paved with concrete at a rather high cost compared with present day prices; and after over 20 years' wear, the pavements are in a remarkably good condition. It was not, however, until four or five years afterwards that much further attention was given to concrete pavements, when Richmond, Indiana, became the next municipality to experiment with them. Today in Richmond one can see some of the very best examples of concrete alley and street paving to be found anywhere in the country, although in a limited amount.

Undoubtedly the reason why concrete pavements until recent years had not become a factor in the paving industry was largely due to the fact that there had been a lack of concerted action on the part of those most interested in the product. It was not until the cement industries and a few large contracting companies devoted themselves to the concrete paving problem that any direct commercial attention was paid to the product.

Reinforcing Steel

Today we have specifications of the most demanding nature for these pavements—the mixture of concrete, the depth, the protection, and reinforcement are important features.

Reinforcing steel is used throughout the better grade of pavements; and it is of interest to note that in Highland Park, Michigan, 40% of the total paving for one year was of reinforced concrete, costing 68%, or approximately two-thirds as much as other types of pavements. It is hardly necessary to state that Highland Park is now using reinforced concrete for pavements in a steadily increasing amount. St. Clair Heights, Michigan, paved during 1913 a total of 15 streets, of which one is not paved with concrete, 14,000 yds. costing $1.92 per yd. The remainder, or 14 streets totaling 61,000 sq. yds. are all of concrete, costing an average of $1.27 per sq. yd. Therefore 82% of all the paving in St. Clair Heights during 1913 was of concrete costing 66% as much as a competing type.

It has been proven in many localities that concrete pavements are comparatively low in cost, inexpensive to maintain, free from dirt, easy for traffic for vehicles of all description and easily drained.

Such pavements should and are usually reinforced with steel, which overcomes the effects of natural expansion and contraction due to seasonal changes of temperature, provides for the contraction of concrete in setting, prevents cracks caused by any inequalities in the sub-soil and prevents the pulling apart of the pavement from the effect of heavy tracking loads coming upon the outer edge of the pavement at a time when the soil underneath that edge is saturated.

Mesh and Plates

A well established reinforcement, manufactured by a cold-drawn process from one-piece metal plates, has been put forth in Kahn Road Mesh, furnished in flat sheets, obviating the annoyance of unrolling coils, cutting to length and fastening in place in the roadway. It is generally used with Armor Plates. These constitute a late and improved method of protection for expansion joints. It has been proven that practically all transverse cracking in concrete roads can be prevented by spacing transverse joints at intervals of 25 to 30 ft. in non-reinforced payments and from 45 to 50 ft. in reinforced pavements. The better results seem to be obtained from a reinforced slab with spacing of expansion joints 45 to 50 ft. The advantages of these plates, including accurate crowning, positive anchorage, etc., have made them popular for this purpose. They are manufactured of soft, open-hearth steel of just the right composition to absorb the heavy shocks and to wear down with the pavement. Plates are 2½ in. deep and are curved to pitch or crown of pavement.

The installation of these plates is quickly and easily accomplished by the use of the improved installing device which is made for this purpose. Specifications for concrete roads of the present day include Steel Armor Plates in many cases.

Curbs.

Concrete curbs properly constructed are a feature of city streets which should not be neglected. They are popular because of their durability and neat appearance. By protecting the upper outside corner of a concrete curb with a satisfactory steel plate the curb becomes superior in appearance and more wear resisting than even the hardest granite curbs. To this end many municipalities have adopted the use of the Kahn curb bar, which has been found to protect and reinforce concrete curbs very satisfactorily. They are also adapted for curved curbs at street intersections, and provide an ample width and thickness of plate exposed to wear.

Three Representative Concrete Roads

The upper view in the accompanying illustration shows the method of ponding in order to cure concrete properly on Bellevue Ave., Hammonton, N. J. The street is 28 ft. wide, 6 in. thick at the sides and 8 in. at the center. The mixture was 1:2:3, and the pavement was built in 1917. The joints are spaced every 30 ft. the edges being protected with Kahn armor plates. The pavement is reinforced with Kahn road mesh No. 25. Remington & Vosbury of Camden, N. J. were the engineers and Michael Staub, of Mamqroneck, N. Y., the contractor.

The middle view is a construction scene on the Easton Allentown road which was built by force account in 1915 by the Pennsylvania State Highway Department. The view shows a Kahn Armor plate being set in proper position by use of the installing device. Attention is called to the fact that the pavement can be readily finished beneath the device, thus insuring an even and uniform surface. The No. 25 road mesh was also used on this job.

The lower view was taken on Baltimore Pike, near Wawa, Pa. This road was built in 1916-17, on State Highway Route 131. It is 22 miles long and extends from Wawa, Pa., to the Maryland State line at Nottingham, Pa. It is 16 ft. wide, 5 in. thick at the sides and 7-in. at the center. The proportions are 1:2:3. The entire road is reinforced with No. 25 Kahn Road mesh, and the section shown was built by Dwyer & Co., of Philadelphia, Pa., under the supervision of the State Highway Department, Wm. D. Uhler, State Highway Engineer.

Construction Plant and Methods Employed in Building South Meridian Monolithic Brick Road, Indianapolis, Ind.

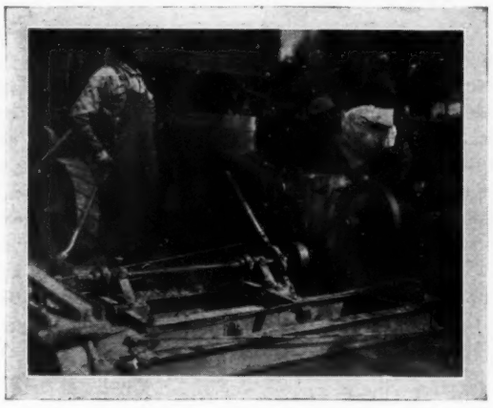
By Maurice B. Greenough, Highway Engineer, Engineers Building, Cleveland, Ohio

The use of mechanical equipment for surfacing the green concrete foundation and grouting the brick as demonstrated in the construction of South Meridian Road, Indianapolis, Ind., represents a distinct step in advance in building monolithic brick pavements. Moreover, machinery made possible a reduction in man-power, an advantage never more timely than now.

Supporting Template.

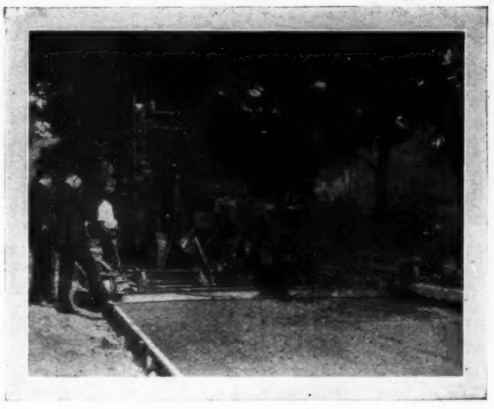
South Meridian road is an important artery of Indianap-

olis. The paving recently built begins at the city limits and extends about one-half a mile southward through the township. The total width of the street is about 40 ft; 16 ft. on



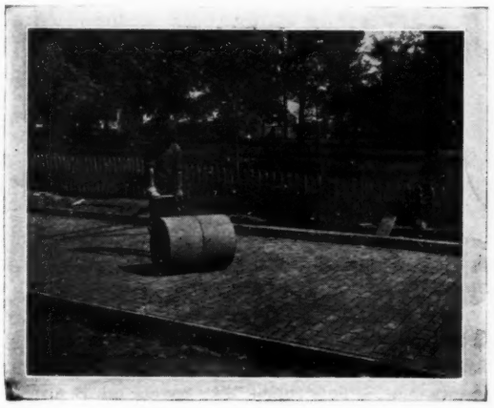
THE MECHANICAL TAMPING TEMPLATE CUTS OFF THE CONCRETE AND TAMPS IT TO UNIIFORM DENSITY AND SMOOTH SURFACE. NOTE THE ROCKER-ARM WHICH TRANSMITS THE TAMPING MOTION. THE TEMPLATE IS DRAWN FORWARD BY THE WIRE ROPE WINDING ON THE DRUM.

either side was paved, and the balance left for a single street car track. In the manner of supporting the template the work represented a composite of city street and country road practice. Concrete curbing was provided at the outside edges



BRICK LAYING AND CONCRETE MIXING 25 FT. APART.

of the street furnishing the support and guide for one end of the template. Adjacent to the street car tracks, steel side forms answered this purpose. The forms were held in position by steel pins spaced 10 ft. apart. The overhanging edge of the forms fitted into a slotted plate attached to the top of each pin, thus holding the forms true to line and grade. A longitudinal expansion cushion was laid along the curb, equal



BRICK LAID AND ROLLED, READY FOR GROUTING WITHIN 25 FT. OF MIXER.

in depth to the combined depths of brick and concrete.

The Template.

The mechanical tamping template used in consolidating, striking off and smoothing the green concrete base performed all these operations simultaneously as well as drawing itself forward. There were three cutting and smoothing edges provided. Two were rigidly framed, while the third was attached

A SMOOTH SURFACE IS PREPARED FOR LAYING BRICK.

to a rocker arm, driven by an eccentric, which gave vertical tamping motion of about ¼ in. The rocker arm raised and lowered the forward and rear I-beams which served to cut off the concrete and uniformly compacted and smoothed it for receiving the brick. Additional smoothness was gained from the middle I-beam rigidly held in the frame work.

WIDE TIRES AND EASILY PORTABLE, WITHOUT DISTURBING THE BRICK SURFACE.

No Hand Finishing Required.

Power was supplied by a 6 h. p. gasoline motor mounted in the center of the rigidly framed members of the template. In addition to actuating the rocker arm, the engine drove a winding drum upon which coiled a wire rope, whose ends were firmly anchored some distance in advance of the template, thus securing propulsion. It only remained to lay the brick immediately after the passage of the template. So smoothly was the surface prepared that no supplemental finishing by hand was required. There was absent in the work at Indianapolis any evidence of misconception of what is sought in monolithic construction, sometimes shown by leaving long stretches of green base exposed with the brick unlaid. As fast as the template had prepared the surface the brick were laid, and all the operations of building the pavement were compassed within a distance of 40 ft. Sweeping and rolling immediately followed the brick laying.

Grouting.

The pavement was grouted with a mechanical mixer. The exact amount of water required was measured in buckets for each batch, thereby insuring uniformity in consistency. The effectiveness of mechanical grouting has already been demonstrated; however, the character of the mix and the dispatch with which the grouting proceeded at Indianapolis furnished further evidence of the desirability of the method.

The paving was done under the direction of Mr. Charles Chaney, County Engineer of Marion County, by the Cunningham Construction Company.

Design and Construction of Concrete Roads in Wood County, W. Va.

By Burdette Woodyard, County Road Engineer, Parkersburg, Wood County, W. Va.

Wood County, West Virginia, has adopted concrete as the standard type of county road construction. We are building our roads 14 ft. wide, 7 ins. thick on the center and 6 ins. on the sides, with 3 ft. berm on either side.

Line and Grade.

The slopes and grades are determined by local conditions. It is thought advisable to spend considerable money in grading rather than to exceed an eight per cent grade. With concrete on this maximum grade we have never had any complaints as to slipperyness. The old road bed is followed wherever possible. Where a portion of the concrete is to be laid over a newly made fill it is rolled to a uniform density, soft spots or spongy places are removed and replaced with suitable material. As the drainage of the road bed is of vital importance it has been found wise road insurance to provide French drains or tile drains wherever needed in the sub-grade. While the fact should not be taken as an excuse for neglect in the preparation of the subgrade, it is nevertheless true that a concrete road slab will bridge over numerous defects of soft spots in the subgrade and no serious results will follow. From our experience we have found that much importance attaches to the destruction and scarrifying of the old road bed in order to have a subgrade of uniform density, under the new road. It has been frequently observed that when we had a soft spongy subgrade and expected cracks in our slabs not a single crack has appeared. What few cracks have developed in our roads have been in slabs partly overlaying the former solidly compacted earth road bed, said Mr. Woodyard in addressing the Southern Appalachian Good Roads Association.

Concrete Materials.

For aggregates we use washed and screened Ohio River sand pebbles. These come to the job separately by team or auto truck and are mixed with cement in the approximate proportions of 1:2:4. The voids in these aggregates run approximately constant and it is, therefore possible to secure a remarkably uniform quality of a concrete. The various ingredients are measured separately in such a way as to insure the proper proportions at all times.

Mixing and Placing Concrete.

The materials are mixed in a batch mixer until the cement is uniformally distributed and the concrete is uniform in color. Only enough water is used to produce a concrete that can be spread into position with a template or straight edge. The amount of water used is not sufficient to cause a separation of coarse aggregates from the mortar and depends somewhat on the water content of the sand. Definite specifications on this point are difficult to observe. Continued experience coupled with a desire for high quality of work will usually provide the best guide. After mixing, the concrete is deposited rapidly upon the subgrade which has been sprinkled, to prevent absorption of water from the concrete. A strikeboard is used to give the surface of the pavement the proper contour and

TYPICAL VIEWS OF CONCRETE ROADS IN WOOD COUNTY, W. VA.

the finishing is done by hand with wood floats operated from a bridge resting on the forms. No one is allowed on the concrete after it has been worked into position until it has thoroughly hardened.

Much publicity is now being given the roller method of finishing as inaugurated by Captain J. J. Gaillard of Macon, Georgia. Uniformly excellent results and low cost are claimed for this method by those who are using it. It is possible that Wood county may see fit to adopt this method if results obtained elsewhere continue to support its use.

Curing Concrete.

Extreme care is always used in curing the green concrete. In hot summer weather canvas is placed on the new surface and kept wet for several days to prevent too rapid drying out. Following this the pavement is covered with several inches of earth and kept moist by sprinkling for a week or more. Where the grade of the road will permit, earth dams are built on the surface and the ponding method is used.

Concrete is weakest when it is new. From tests made both in the laboratory and in the field it has been demonstrated that during the first five years of its life concrete is constantly increasing in strength and in ability to resist the wear of traffic. Our experience has been that the longer traffic can be kept from a new piece of concrete the better it will be for the road and the possibility of its acquiring those qualities of hardness and toughness which are characteristic of this type of road when properly built. Our roads are not opened to traffic in less than two weeks. This period is extended if no serious inconvenience is occasioned by a further delay to traffic.

Joints.

It has been our practice to install at intervals of from twenty-five to fifty feet metal protected joints of the bituminous fiber matrix type. The tendency of our present practice is to lengthen the interval between joints. On long slabs over newly made, heavy fills where there is a possibility of further settlement, the joints are omitted altogether. Our theory here being that if cracks should occur the inter-locking effect of the coarse aggregate will prevent any relative motion of adjacent slabs and thus preserve a smooth riding surface.

Up to the present time reinforcing has not been extensively used, although the question is now being considered as to the advisability of omitting the joints and putting the money thus saved into reinforcing.

Wood county has found that by using good clean materials, careful and painstaking workmanship, followed up with proper curing, it is possible to secure a concrete pavement that is practically indestructible. The wearing qualities of these roads are indicated by the fact that on some of them now going into their sixth year of service, the finish marks of the wooden float are still clearly to be seen. Concrete roads built five years ago have never had a penny spent on surface maintenance. The maintenance has been built into roads.

WATER WORKS MAINTENANCE AND OPERATION

Practical Measures for Securing Greatest Economy in Public Utility Plant Operation

I.

By Charles Brossmann, Consulting Engineer, Indianapolis, Ind.

(This is the first in a series of six articles by Mr. Brossmann, giving specific recommendations on measures available for increasing the efficiency of public utility power plant operation, with special reference to the power plant end of the public water works system. This is a neglected and imperfectly understood phase of water works operation and in these times of high costs is supremely important.—Editor.)

How much efficiency will my Pumping Plant or Utility Plant give is asked by the Operator?

This question is similar to the City Man's inquiry of the Farmer asking, "How much milk does your cow give?" "She don't give none," said the farmer, "you have to take it from her by force." Your Power Plant whether it be a water, lighting, heating or whatever kind it be will only give efficiency when you make it do so.

One hesitates to write an article on Efficiency in the Pumping or Power Plant as the word efficiency has been somewhat abused; more so, however, in industrial than in utility plants. In some industrial plants so much red tape and system has been devised that it has become a burden and the cumbersome records have only been good as items of statistical interest. This has not been so true in the utility plant for the reason that usually it has not been realized that conditions could be improved, and the operators have been content to go along as they have been accustomed to as long as the plant seemed to operate smoothly and satisfactory service was given.

Inefficient Use of Coal

According to the Director of the Bureau of Mines, last year alone, at least one-half a billion dollars was wasted throughout the country by inefficient use of coal. Of 600,000,000 tons of coal mined in the United States last year, the Director of Mines states that we wasted 150,000,000 tons through inefficient use. It can readily be seen that if it were possible to get the utmost efficiency from the thousands of steam users and power plants in this country that the coal situation would be greatly improved over present conditions.

Coal Situation is Acute

Since the war started, the coal situation has developed into an acute question and much more thought is now being given to the question of economy where formerly it was lightly passed by. It is not altogether a case of paying the extra price for coal but it is a case of getting the coal at all.

England has already established a Coal Mines Department, and fuel directors have been appointed in this country. So that the men who formerly did not worry about how inefficiently he operated will now have to look this question squarely in the face.

Small Plants Most at Fault

The larger plants of the country and of course many of the small or medium size plants obtain good economy of operation but the greatest chance for saving is in the hundreds of small plants. As a general rule the large plants are not so susceptible for improvement in power plant efficiency as the smaller plant, as the coal cost percentage is greater in the smaller plant.

Roughly speaking for comparison one may say that a 2,000 H. P. plant would convert 12% to 13% of the heat energy of the fuel into power. Whereas if you take a small plant, say of a few hundred H. P., only about 3 to 4% of the coal energy is developed into mechanical energy. These figures of course are approximate estimates but they show why the small plant must be very much improved to gain the economy practiced in large stations.

Where the same plant is properly operated and where conditions are very favorable quite a high degree of efficiency can be obtained, but every small item must be watched and the many little wastes that creep into power plant operation must be kept at the minimum.

Time to Get Down to Facts.

Right now is the very time to get down to the facts and ask yourself: "What is my Plant doing and what can I do to better conditions?"

The Marathon runner does not start off at once with a great spurt but distributes his efforts throughout the entire course. Study his methods and apply them to the operation of your plant. Get at the question of power plant operation systematically and eliminate inaccuracy and adopt definite and accurate methods. Cut out all waste and even if it does seem small you will be surprised at the results. Those who have already done this, I have no doubt, look back with pride at what they have accomplished. If your plant needs economic changes in operation or installation, it cannot be done in a day. The matter must be carefully studied and viewed from every angle.

Firemen Must Be Encouraged

Recently, I watched a fireman who would fill both sides of the grate under the boilers shoveling in about twenty scoops of coal. He would then sit down or go away and not come back

for 20 minutes. I started him off firing under one side at a time and putting in only a few scoops of coal. After two hours work he seemed inclined to get discouraged as he thought that he could not notice any improvement. He had been firing his way for several years and he did not like to change. He learned how to do his firing from the man ahead of him, and of course, it was not his business and neither could you expect him to think in terms of C. O. 2 or excess air or other unheard of things. This only goes to show that innovations or new methods are hard on some men. The fireman must be encouraged and explanations made and reasons given to get him in line and this is one of your first tasks.

This dirty old boiler room (but I apologize if yours is clean) is the place where you can pay the biggest dividends in your plant. I do not mean to slight the other places; but the constant stream of Black Nuggets flowing through your boiler room represents the work of perhaps millions of years that Old Sol, and the other forces of nature untiringly gave to us. You, of course, are not responsible for all of the loss in the coal but it is the little 1, 2 and 3% losses that, when added together become large, should be taken care of.

Some day a great wizard will probably devise a new method of utilizing the energy of fuel, but this should not make you forget that under present conditions at our very best we cannot help but be wasteful.

Save at the Coal Pile

It was not so many years ago that Indiana was a great gas field and many times I have seen ordinary steam pumps taken and the pressure of gas passed through the steam cylinder as a motive power. Gas was wasted in every conceivable way and today Indiana is dead as a gas field. Therefore, I say, save all along the line but above all at your coal pile which is the foundation on which to practice economy.

The man who wheels in and fires the coal is the one to start on. There is an art in wheeling in and shoveling a barrow of coal, as one fireman remarked to a newcomer. "Drop that wheel barrow; what do you know about machinery?" And if you don't believe this let a fireman from a small saw-mill plant try to fire a locomotive.

Now the preventable waste of coal in this country runs into astonishing figures, even in many large plants as well as the small ones. Try to realize what this means in some big industrial plant using say 20,000 to 30,000 tons of coal a year where the boiler efficiency might be raised 10%.

Lame Excuses

Your boiler plant may only be giving an efficiency of 50% or even less. This is nothing uncommon. But what is your excuse? Ignorance of conditions? That is no excuse. The fact that you as superintendent leave this to your engineer—or that you are running with as little coal as some other plant or a multitude of other reasons do not let you out. You have no instruments or no proper forms to keep records. Well these are easily obtained. A few dollars will start you off and if the powers that be will not pay for them and buy you more and raise your salary when you have produced good results, at least you have made a showing and have some new valuable knowledge which will help you along to better things when the opportunity to change comes.

"Freely give that you freely receive." It will be more than paid back in the end.

Ignorance of Costs

Here is a plant, a public utility, which argues that rates should be raised for this particular service, yet in their yearly report to the State Commissioner, they state "We cannot give the amount of coal per unit of power used." How do they know they are entitled to a raise if they cannot diagnose their operating costs? Many utilities pump not only water but generate light, heat and power and some even manufacture ice, yet do not know what each branch of service is costing them except in the most crude way.

I admire the Theosophist and have respect for his belief. His religion is pure and gentle. He does not jamb it down your throat or force it on you. But it is no religion for the saving of coal. I think the Coal User needs more drastic measures—he needs a little jolt to wake him up because coal has been so plentiful and easy to get that many have become careless and wasteful.

Poor Measures of Efficiency

Some men who run their plants state, "I know our boilers are operating efficiently. I can tell by the color of the fire."—(Can he see the color of the air leaking and seeping through the boiler walls?) Another tells me: "I can tell by the coal pile that we are operating economically." That is wonderful second sight, and without striking a balance sheet between the coal used and power made.

Can you imagine a big department store keeping in business that featured many bargain sales and not knowing what each department was paying! They know just what they are making and losing or they could not continue in business—neither could any big modern concern as a general rule unless they knew.

Know and Study Results.

Every bank strikes a balance sheet each day and at the close of the business day they know just what has come in and exactly what has gone out. But how many power plants know at the end of the day how much coal was burned and how many pounds of steam were made from that coal, and how many gallons of water were pumped with the steam or how many Kilowatts generated? And even if this is known have the results of such a balance been scrutinized and shown anything? If you have the proper records, have you given them the thought they merit? Are the results of water evaporated per pound of coal up to what they should be for your type of boiler and load? Is your feed water hot enough, or are draft conditions in the boiler the best for that day? Do you know whether the boiler is sooted up or tube passages filled with ash? Is the coal to blame or is it some other reason and if so what are these circumstances and how shall they be determined and remedied?

Are you sure that even if your boilers are operating with economy that your steam driven units are in the proper shape? And all steam lines tight and drains and traps without leakage? Has your pump or engine had an indicator on it in the past six months? If not how do you know the valves are tight or set properly?

Must Economize Coal

All of these are perhaps small matters and your plant is only one of a multitude but do not forget that present conditions of production in every line are unusual and the resources of power plants throughout the country are being taxed to the utmost. You are only one of a great team and you should bear in mind the necessity of getting every available heat unit from the coal, every ounce of work from the steam and then deliver your product as economically as possible and with minimum waste.

Do not forget that the mines are not delivering all the coal that we need, that we require more than the mines are usually producing and that the demand is steadily increasing.

How is such a shortage of coal to be taken care of and supplied? In some cases by structural alterations such as new and more efficient machinery, but this is not possible in many cases.

If the coal output cannot be increased then to produce the power the needed results can only be obtained by rigid economy.

Conditions Call for Remedy

The conditions call for prompt and immediate results and

this is entirely possible if strict and intelligent management is practiced. When one considers the vast amount of coal used it is safe to say what hundreds of thousands of tons can be saved annually if every one will do his part. No trouble shall be found in making a saving in the country's fuel of from 10 to 20%. But it means work and constant vigilance and proper co-operation on the part of all parties concerned.

Where shall this start—shall it be compulsory by the Government? This may not seem to be democratic and no doubt would be strongly objected to at least until it were shown to be of advantage in a financial way.

One other way is open and that is on an educational basis, but before any educational system can be a success coal users must place themselves in a receptive mood and have the desire and willingness to work toward such an end, otherwise it will be a failure.

Instruct Operators

It will require tact, study and application. Any system of teaching must not be complex or confusing as the greater part of the saving must be made by the men actually operating the plant. This therefore, calls for direct and simple methods that will be readily understood and easily executed.

The start, of course, must come through the owner, manager or superintendent and thereon down through the chief engineer and down to the firemen. The last being just as important, if not more so, than the owner or manager, as a poor or unwilling fireman, if he tries can, as a rule, shovel more dollars to oblivion than any other agency. A good fireman can make a wonderful difference in the cost of operation.

Therefore, let the first step be educational and in such form and terms as to be readily understood by those who are most responsible. The chief engineer or superintendent can place his instructions and recommendations in such shape that the fireman can understand them and go at it in such a way as to arouse his interest, if possible, for the saving of greater amounts will lie in the hands of these men. Start with them and the small things, such as the heat units (B. T. U.'s), and your total will soon be something worth while.

The Slacker B. T. U.

Behold the nimble B. T. U.
Now hastens toward the lofty flue,
He dances from the coal so black
Around, across and up his track.
Along the furnace fiery walls
He dives and jumps, but never crawls;
Elusive, he, and small in size,
He's never seen by human eyes
But hastening through the sooty tubes
In countless numbers—moves and moves
On through the baffles up and down
Against the shell so smooth and round,
Pushing and crowding here and there
And mingling with the excess air,
Some holding back, a select few
Exclusive with the C. O. 2,
To do their bit and turn to steam
The seething water hot and clean.
But all the rest now rushing go
On through thhe breeching to and fro,
Rushing in haste to reach the stack
A crowd of Slackers, a lazy pack,
Up through the stack and to the air,
On, on they go; Do we despair?
Ten thousand strong to every pound,
The work of Ages in the ground,
Now and forever more they're lost
Into the great unknown they've crossed.
Quick! Plaster the Brick work, close the cracks,
Change the draft, and raise the stack,
Level the fires, shovel the coal
A scoop at a time if you'd reach your goal,
Or the nimble heedless B. T. U.
Will prove much more than a match for you.

The Dual System of Water Supply Recommended for Eastern Cities

By Robert J. Thomas, Superintendent of Water Works, Lowell, Mass.

What is the ultimate solution of the problem of supplying water to cities situated in more or less congested centers of population, such as those found in the eastern section of the country and especially in eastern Massachusetts?

Increasing Supply Is Difficult in East

Many of these cities have no available sources of supply large enough to meet their constantly growing needs, and the prospect confronting them is indeed anything but encouraging. The local streams and lakes which offered a natural means of supply are either too small or have been polluted from various causes. Some cities are using these impure waters after filtration. Other cities are getting a meager supply of ground water by means of driven wells, but as a permanent, stable supply both are mere makeshifts and cannot prove satisfactory or sufficient in the long run. Especially is this criticism true of driven wells or ground water supplies, for although the water is of good quality, it is too limited in quantity to furnish an adequate supply for manufacturing, street sprinkling, fire extinguishment, sewer flushing, power, etc.

Not only is water of good quality limited, but it is far too valuable for many of the uses to which it is put, even for some domestic purposes, for which an inferior quality of water would answer just as well. Bearing in mind the scarcity of good, clean, wholesome water and its dire necessity for drinking, cooking, etc., is it not sheer waste of a valuable commodity to apply it to uses where common, ordinary, untreated water from brooks, rivers and ponds would suffice?

Wisdom of Conserving Pure Water

Vast sums of money are expended to make water potable, and then it is applied to the extinguishment of fires, flushing sewers and various like purposes, altogether a different use than that for which it was rendered suitable at a considerable cost. This is certainly not in the line of efficiency or economy.

A consideration of these facts must convince anyone of the prudence, economy and wisdom of conserving the good water for the purpose which nature intended it, and supply for manufacturing and fire service purposes a water which can be obtained at much less cost. In other words, another system of water works should be built and separate pipes laid to convey water for many of the uses for which purified water is now consumed.

The Dual System of Supply

This means what is sometimes called a "dual system," and is objected to on account of its alleged excessive cost. The word "alleged" is used advisedly, because no thorough study has ever been made of comparative costs.

Answers to Criticisms Against Dual System

It is undoubtedly true that the cost of laying two mains would be greater than laying one main of equal carrying capacity and that two service pipes would enhance the expense for supplying water, but it does not follow that a dual system would require double the outlay of a single system, as some people maintain. For instance, large reservoirs at high elevations and large pumping plants are the outcome of the demands of underwriters for extreme high pressure for fire extinguishment, and are not necessary for the supplying of water for domestic or commercial use.

It is urged against the dual system that there isn't space in the streets for any more structures than we have; still, all the very large cities like New York, Boston, Philadelphia, etc., have high-pressure water mains in their streets in addition to the regular water mains, together with subways and many other structures, so that is not any great obstacle.

The point of this discussion is that when cities having a practically complete water works system, both for public and private service, are forced to improve the quality of the water supplied because of its menace to public health, instead of undertaking to purify their old supply, procuring a new and safe source adequate to supply their total consumption, plans should be made for the design and erection of an additional system for supplying a pure, wholesome water for drinking, culinary and laundry purposes. The first cost of construction would not then appear so appallingly large and the cost of operation would figure out to be less than the cost of maintaining and operating a huge single plant with its attendant large expenditures for filtration and purification of the quantity of water needed for every use; also, pumping all the water against high pressure for fire service when only a small portion of it is consumed for that purpose, would be avoided.

Probably the best plan of a Dual Water Works System would be to build a separate system for fire service and operate the old plant, with modifications, for all other purposes.

A Specific Example

I have in mind a city of 100,000 people consuming an average of 6,000,000 gals. daily. The supply is ground water, cool, soft, clean and wholesome but limited in quantity to about 10,000,000 gals., leaving but a small margin of supply over consumption especially during periods of excessive consumption. To increase the supply is imperative as the city is growing rapidly but the prospect of getting enough ground water is very doubtful. In case the wells fail to yield a sufficient supply, the only alternative is a source of supply 30 miles away, which would cost about $2,000,000 for a single pipe line to bring this water into the city.

My idea would be to conserve well water for domestic purposes and go back to the old river supply, which served the city before the wells were installed, for manufacturing and for fire and other public uses. By following this plan, well water would prove sufficient for many years to come because of the saving in its use.

Like in many other cities, the manufacturing, business and high value district generally is centrally located and could be served for fire purposes without excessive cost as far as laying new main pipe is concerned. Also, the hydrants in the residential sections could be allowed to remain as they are and not signify much in the consumption of water.

I know of no place where the Dual System of Water Supply is in use, but I believe the subject is well worth study and investigation.

The Mechanical Cleaning of Water Mains in Rochester, N. Y.

By Edward H. Keith, Resident Engineer, The Underwriters' Bureau of the Middle and Southern States.

Rochester, N. Y., a city of about 275,000 population situated along the Genesee River, seven miles from Lake Ontario, is provided with a double system of water works; one for fire service only and one for both fire and domestic service. The former is a district pumping system and takes its water from the Genesee River. The latter is a gravity system supplied from Hemlock Lake about 30 miles distant.

Cleaning Fire Service Mains

It is the cleaning of the fire service mains or "Holly" system that is of special interest at this time on account of the serious obstructions found in that system.

The Genesee River flows through a clay and limestone country and at times the river is very roily, bringing down large quantities of mud, clay and leaves, and the water is pumped directly into the mains without filtering or even passing through a settling basin.

Sprinkler Equipment Full of Mud.

A few years ago during the dismantling of the sprinkler equipment in an old building, the writer noticed an accumulation of sediment in the smaller sprinkler pipes and on a more careful inspection many of the smaller pipes, 2 in. and under, were found completely filled with mud and clay. This started an investigation of all of the older sprinkler equipments and many of them were found in the same condition.

The worst conditions, however, were found in systems that had a gravity tank for a second supply and the gravity tank feeding into the sprinkler system from the top of the riser instead of from the bottom as the modern practice requires; the gravity tank being filled by an independent line provided with a float valve. In some cases the upper half of the gravity tank was used for flushing the toilets throughout the building and there was a constant flow of water into the tank and the sediment settled to the bottom gradually filtering down into the system and in time filling the laterals and cross mains with a compact mass of mud and clay.

Some of these older systems were entirely removed and replaced by modern systems while others were cleaned out by flushing or scraping or by forcing wires or plungers through the pipes; in some cases it was necessary to remove the pipes before the sediment could be dislodged on account of its compact condition.

Investigation of Street Mains.

The discovery of the condition of the sprinkler systems led to an investigation of the street mains and for some time, whenever a cutout was made in the mains the writer was present and noted the condition; in some cases the mains were found free from sediment but in many cases from 1 to 4 ins. of sediment was encountered.

The "Holly" or Fire service mains were laid about 45 years ago and until within a few years before the writer started his investigation, had never been cleaned. In talking over the conditions of the mains with a former Mayor of the City he remarked that the most disconcerting fact was that he had never dreamed that such a condition was possible.

Cleaning Domestic Mains

In 1908 about 13,000 ft. of 6, 8 and 10 in. mains were cleaned in various parts of the city; again in 1909 and 1911 about 22,000 ft. were cleaned by National Water Main Cleaning Co., of New York. Nothing further was done until 1916 when owing to some complaints of dirty water in the domestic service mains, the same cleaning company were called upon to clean about 16,000 ft. of 6 to 20 in. domestic mains. Only a small amount of sediment was found although there was a considerable amount of tubercle scale or rust. In some places, however, the water discharged during the cleaning was very black.

Cleaning Fire Mains.

The writer took advantage of this work to ask the Water Department to clean some of the "Holly" mains in the vicinity of the risks where most serious conditions had been found in the sprinkler systems. About 4,500 ft. of 6 and 8 in. "Holly" mains were cleaned and from 2 to 4 in. of sediment together with a considerable amount of tubercle scale was found. In an 8 in. main that had been cleaned 8 years before 4 in. of sediment was found and the Cleaning Co., stated that this same amount of sediment was encountered at the former cleaning. The cleaning of the "Holly" mains was continued in 1917 and the work of cleaning was started in a more systematic manner and conditions that were not thought possible were discovered.

Sediment in Mains.

Starting at the pumping station the 20-in. feed main was entered and little or no sediment was found, but a considerable amount of sponge growth was encountered; this condition continued until the first right angle bend occurred a distance of about 600 ft., when sediment began to appear and for a distance of about 2,000 ft. to the central distribution point from 4 to 12 in. of mud and clay were found. Where the greatest amount of sediment occurred, the 20 in. main was reduced in cross section area 75% and the carrying capacity of the main reduced 50%.

After the cleaning machine had been sent through the main the street was covered from curb to curb for over a block with mud, clay and scale. The main at this point reduced to 16 ins. and while only a small amount of sediment was noticed at the cut out, the sediment came out in large chunks and there was so much of it thrown up into the street that it had to be removed by the wagon load.

Tubercle Scale and Rust.

This condition occurred in the lower portions of the City. Further away from the pumping station and in the higher portions of the city there was less of the sediment but a considerable amount of tubercle scale or rust was encountered.

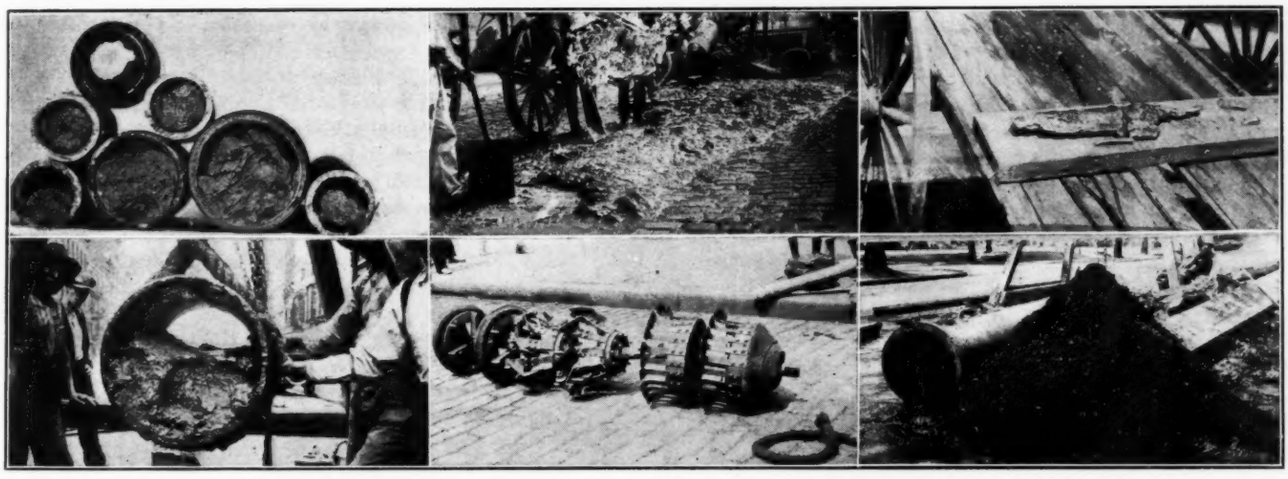
served: After shutting off the water, the main is uncovered and opened up in two places and a section at each place removed. The distance between the cuts varies according to the general conditions of the mains, the character and size of the cross mains, the angle of curvature at the bends, etc. A "go-devil," or cleaning machine, is placed in a new piece of pipe the same size and length as cut out; this is made up and leaded in as a permanent part of the main; at the other cut out, which may be 100 ft. 5,000 ft. or several miles distant, a riser pipe, of the same size of the main is made up and extended to the surface with a 45 degree bend.

Cleaning Machine Water Propelled or Cable Drawn.

When all is ready, a gate, near the place where the "Go-Devil" has been inserted, is partially opened and the "Go-Devil" is shot through by water pressure and comes out through the riser pipe. In some cases instead of shooting the "Go-Devil" by water pressure, it is drawn through by cable and windlass, a steel rope to which the machine is attached having been previously shot through by special carrier.

Removed Material Flushed Out Through Riser Pipe.

With either a cable drawn or a water propelled machine a certain amount of water is allowed to pass the machine in order to carry ahead of it the dirt and incrustations which have



VIEWS OF MATERIAL REMOVED IN MECHANICAL CLEANING OF WATER MAINS AT ROCHESTER, N. Y.
Top Row (Left to Right): Sprinkler Pipes Filled with Sediment. Mud and Clay Removed by Cleaning Machine. Surplus Lead Found in Main. Bottom Row: 12 ins. of Sediment in 20 in. Main. Cleaning Machine or "Go-Devil." Pile of Tubercle Scale and Rust Removed.

Excess Lead in Mains

In the cleaning of the mains several interesting conditions were found; conditions which could be discovered in no other way and which affected the integrity of the distribution system. For instance, in forcing the cleaning machine or "Go-Devil" through the mains the machine on several occasions suddenly stopped and on digging up the street, after determining its location by measurements, and breaking into the main, more or less lead, used in calking the joints, was found on the bottom of the main—as much as 40 lbs. being found in a single piece. In one instance, in a 6 in. main a piece of lead 16 ins. long and 2 ins. thick was found. This had effectually stopped the machine and was found partially curled up by the cleaning blades. In other instances partially closed gate valves were encountered.

The sedimentation of these mains had been going on for years and it is quite probable that the 12 ins. of deposit found in the 20 in. feed main had been in the main for many years and had reached a point where the velocity through the restricted area was sufficient to prevent a further deposition and had thus maintained an 8 in. clear water way.

Method of Cleaning.

In the cleaning of these mains the following method is observed:

been cut and ground up by the machine and this sediment and cleanings are carried to the surface of the street through the riser pipe. After the machine has passed through the main the water is shut off, the riser pipe removed and the main at this point reconnected and all valves again opened. During the cleaning all valves in the cross mains are also closed and men are stationed at the various shut off gates along the line of the main to be cleaned and provided with telephone receivers to note when the "Go-Devil" passes those points.

Successful Application of Producer Gas Engines in Water and Electric Light Plant

The Vassar light and water plant in Vassar, Mich., has two Bruce-Macbeth producer gas engines of 75 and 125-h.p. capacity, operated by a producer which uses coal and automatically generates gas. Splendid results have been secured with this plant. Walter Clingenpeel, superintendent of the plant, is much pleased with the way the engines are working and he pronounces them easy to handle and says they are economical in fuel consumption. When the old plant closed down in August, 1917, it was using more than 5 tons of coal

in a 14-hour run. At the end of November, using the new gas engines, the plant was burning only from 900 to 1,200 pounds of coal per day of 24 hours. This not only indicates a big saving in fuel, but one man less is required to run the new plant than was employed in the old. Clingenpeel states that the city council and citizens are much pleased with the outcome, and in these times of fuel scarcity he advises other cities to buy Bruce-Macbeth engines and Milwaukee Reliance gas producers. He states that they make a good combination and prove highly satisfactory as well as economical and efficient.

WATER PURIFICATION AND SEWAGE TREATMENT

Industrial Waste Problems with Reference to the Smaller Cities

By Langdon Pearse, Division Engineer, the Sanitary District of Chicago, in Charge of Sewage Disposal Investigations.

With the growing attention given to the question of sewage treatment from the standpoint of the municipality to avoid nuisance or reduce pollution of water supply, interest is increasing in the problem of handling industrial wastes. Such wastes are not necessarily an indication of uneconomical operation on the part of the manufacturer, but may be a condition which has come down from the time when the pollution of streams was not so closely watched by the federal, state or municipal authorities. In many cases, however, the attention of the manufacturer has been drawn to leaks through the stoppage of which valuable sources of revenue have been found. The purpose of this article is not to deal in extended details of treatment, but to sketch briefly the problem found in different conditions and the general lines of action followed to obtain relief.

There are two general aspects, one the sewerage or sewage treatment problem, with many ramifications, which is commonly met, the other the water supply problem where industrial wastes pollute water used for drinking purposes.

Water Pollution by Industrial Wastes

The cases of water pollution are not so frequent. A few which have come to my attention may be of interest. In Maine, the sulphite waste liquor in the Kennebec gave the river water a slight taste or odor as used at Augusta. As the river was badly polluted with sewage, other sources of water supply were obtained. Along the shore of Lake Michigan, the wastes from a corn products factory in Waukegan at one time caused much complaint. Some alleviation was had through lime treatment. The factory burned down and has not been rebuilt. At Whiting, Ind., the small amount of material escaping from oil refineries gives the water a decided kerosene odor or taste. Experiment has shown that this can be removed by aeration and proper coagulation, followed by rapid filtration. At East Chicago, Ind., certain directions of wind blow surface currents to the intake from the outlet of quench water from coke ovens of large steel companies. This quench water apparently produces an odor or taste akin to the after taste or odor of an excessive dose of chloride of lime. In other parts of the country rivers may become salty from the waste from oil wells. Where possible, different source of supply should be sought; otherwise remedial treatment should be studied.

Effect of Industrial Wastes on Sewage Problem

From the sewage standpoint, there are several points at which the city officials may confront the manufacturing problem. First arises the question of maintenance of sewers to avoid deposits, deterioration of structure, freedom from local nuisance, and freedom from explosive gases, or gases dangerous to workmen in the sewers. Next is the problem of disposal. If the town is happily situated on a body of water of ample diluting capacity, the problem is simple. Often no treatment is required, or the removal of floating material may suffice. Where the town is so situated that treatment is a necessity, the problem is usually complicated by the presence of industrial wastes. Only a careful survey of the situation, followed perhaps by actual tests, can indicate the steps to be taken.

Classification of Industrial Wastes

The various industrial wastes may be briefly classified as follows from the physical as well as from the chemical standpoint:

1. Wastes carrying sediment.
   a. Heavy mineral matter such as marble dust, stone grit, ashes, etc., usually inert.
   b. Heavy organic matter, largely of vegetable origin, such as refuse from canneries, pulp, distillery refuse, etc. This may be putrescible.
   c. Heavy matter produced by chemical re-action, etc., such as tarry wastes from gas works, residues from ammonia works, etc.
   d. Heavy organic matter of both animal or vegetable origin, such as Stock Yards or Packingtown wastes. This may be highly putrescible or comparatively inert.
2. Wastes carrying little or no sediment.
   a. Containing soluble organic matter. This may be highly putrescible.
   b. Containing chemicals.
      1. Eager to absorb oxygen.
      2. Inhibiting bacterial action.
3. Wastes carrying both suspended and soluble matter.
4. Wastes carrying floating materials.
   a. Volatile and inflammable, as for instance gasoline or kerosene.
   b. Fats and oils.
   c. Light organic matter.
   d. Light matter the product of chemical reaction, as floating material from gas wastes, etc.

Industries Producing Wastes

The various classes of wastes covered by the foregoing summary may include a wide range of industries, which may be briefly mentioned, as follows:

Stock yards, slaughter houses, (including packing houses and allied concerns), poultry dressing houses, sausage-casing factories, wool scouring and pulling, glue works, butterine factories, gas works, tar-roofing works, makers of starch and other corn products, tanneries, wire mills, foundries, breweries, distilleries, beet-sugar works, dairies, marble works, paint and dye works, oil refineries, canneries, strawboard and paper mills, and garages. In almost every form of industry where water is used for other than cooling or condensing purposes, some waste is added to the outgoing water, the importance of which from the standpoint of the maintenance of sewers or sewage treatment works or the pollution of streams can only be determined by inspection or analysis.

Effect on Sewer Operation

From the standpoint of operation of the sewer system itself, the problem may quickly become prominent by accumulation of large amounts of deposits. In Fort Worth several years ago paunch manure from the stockyards choked up a 24 in. sewer pipe for several hundred feet, flooding backyards in the vicinity. Refuse from the canning industries may make deposits where waste pulp and spoiled fruit are deposited in the sewer. A very frequent cause of trouble is spent-lime from tanneries. The stand and sediment from stone-cutting operations may also cause deposits, and occasionally deposits are traced to strawboard factories.

Volatile Material Reaching Sewers

There is also the important question of reducing the amount of volatile material which may reach the sewer, particularly gasoline. Of late years, a number of disastrous explosions in sewers have occurred traceable to gasoline. Leaky gas pipes have also proven a source of trouble, but not so markedly of late as gasoline. In Chicago, a trap or skimming basis with three compartments provided with baffles under water is required on all garages to hold gasoline or light oils which might enter the sewer. Similar traps or skimming devices of larger size are also in use in tar-roofing industries, oil refineries and gas works to retain floating tar. In engine rooms oil is occasionally wasted and spent oil discharged into the sewer. Oil traps will prevent this. Further many cities prohibit the discharge into sewers of steam or trade wastes at high temperatures.

Explicit Chicago Ordinances Regulating Use of Sewers

On both the foregoing points, the municipal ordinances in Chicago are decidedly explicit.

"Section 790. Steam discharge in sewer prohibited. No person shall make or use or cause to be made or used any connection with or opening into any sewer or drain for the conveyance or discharge into such sewer of drawn-off steam from any steam boiler or engine, or from any manufactory or building in which steam is either generated or used, under a penalty of $50 for each and every day during any part of which such connection or opening may have been used for that purpose."

"Section 791. Obstructing sewer penalty. No butcher's offal or garbage, dead animals or obstructions of any kind whatsoever shall be placed, thrown or deposited in any receiving basin or sewer, and any person so offending or causing any such obstruction or substance to be so placed so as to be carried into such basin or sewer shall be subject to a penalty of $10 for each offense....." While such penalties are small, it is to the credit of most offenders that they will spend many times such amounts in endeavoring to improve conditions.

Effect on Sewers of Acid Wastes

Sewers, also, should be watched where the discharge of acid wastes occurs. In most localities, the sewage is alkaline and there is generally sufficient alkalinity present to take care of ordinary discharges. As a general rule, threatened injury to sewers of whatever material, from the structural standpoint, has come from the generation of hydrogen sulphide due to putrefying deposits or exceptionally stale or septic sewage. These conditions may be induced by the presence of industrial wastes, although not necessarily. In the smaller sewers however, the discharge of acid wastes from the pickling vats in wire mills, foundries, sheet metal or pipe works may sometimes need attention, as the volume of domestic sewage may not be sufficient to neutralize the acidity. Such cases, however, appear rare. Neutralization may be adopted. Recovery of iron sulphate by evaporation is frequently practicable, where the volume is sufficient to warrant. The gradual outflow of wastes throughout the 24 hours of the day rather than sudden discharges may prove helpful.

Industrial Wastes and Stream Pollution

When the sewage enters the stream or other outlet for disposal, further developments ensue. Many industrial wastes have a high content of putrescible matter, which of itself will undergo intense putrefaction. Other wastes, though high in organic matter, may be of themselves practically sterile, but when mixed with domestic sewage or a polluted stream, rapidly decompose. Included in such wastes may be the starch or corn products wastes, which furnish excellent food for bacterial decomposition. Consequently the bacterial content of a waste or sewage, is not necessarily regarded as an important index, except where the pollution of a water supply, or contamination of bathing beaches or shell-fish beds are in question. Wastes rich in corn products, sugar, etc., while in themselves seemingly harmless, when broken down by decomposition, may produce most offensive nuisance, and often prove the most difficult to abate.

Effects on Fish Life

In considering the effect on a stream, the demand for oxygen, is of course, important as an index to the dilution capacity of the stream at various stages. The exhaustion of the oxygen points to probability of nuisance, and further the death of fish. Aside from this extreme condition, even where considerable oxygen is present, from the standpoint of fish life, certain wastes particularly from gas works are highly deleterious. Gas and tar refuse are particularly damaging, even in small amounts, since they tend to give the flesh of the fish a tarry taste which may make them wholly unfit for sale. This is particularly noticeable where a gas works discharges into water which otherwise may be very suitable for fish life.

Floating Wastes Objectionable

The importance of retention of floating wastes is readily apparent. Grease, oils, and tar have a definite value, in normal times, which is much greater in these war times. Furthermore the slick of oil or grease spreads widely in a stream, and quickly occasions unfavorable comments. Yachtsmen also complain of the discoloration of their boats by such forms of refuse.

Effect on Navigation

From the standpoint of navigation in a stream below the discharge of the sewer, the amount of sediment, particularly where inert, may prove of importance. This is particularly true where the sewer discharges into streams of low velocity or slack water. A large glue works alone may discharge over two tons of lime a day, or perhaps as much as 20 cu. yds. of sludge a day. Beet sugar works, packing houses and tanneries may also be large producers of sludge.

Local Nuisance

In most cases, the complaints of nuisance come from objectors situated along the stream below a town, or inside the municipal boundaries. Occasionally the question may arise of nuisance caused by the discharge of industrial wastes into the city sewers in the city itself. For instance, in Decatur, Ill., considerable complaint along the line of a trunk sewer has been caused by the discharge of starch wastes into a domestic sewer which then flows about two miles through the city to the outfall. The only way to satisfy public opinion was the complete diversion of the waste from the city sewer, into a closed sewer extending to the outfall.

Skimming and Catchbasins

From the standpoint of the local sewer system, ordinances are generally drawn to operate under the police powers of the municipality in the regulation of the discharge of wastes. Most acts of this character have been directed toward prohibition of sediment by the requirements of catchbasins or directed toward the retention of floating matter by suitable skimming basins. In some cases special action toward direct removal of wastes from the city sewer has been needed, as in

the case of the wool wastes of Hudson and the starch wastes of Decatur. Organized removal of sediment by catchbasins from tannery centers is well illustrated by the basins of the tanneries on the North Metropolitan sewer in the Metropolitan Water and Sewerage District serving Boston and its surroundings where from 5,000 to 8,000 cu. yds. of sludge are removed yearly. In Gloversville, N. Y., where tannery wastes are especially prevalent, catchbasins have been required in order to prevent deposits in sewers and reduce the load on the treatment works. In both cases the preliminary treatment was needed to insure the operation of the sewers.

No Established Standards for Treatment

At present there are no established standards for treatment. An inquiry by the author, several years ago, as to general practice in such matters brought out the fact that in most states the engineering heads of the various State Boards of Health solve each case according to its merits. A study of the literature on the subject shows a variation in the standards of treatment proposed, those by the Royal Sewage Commission in England being especially severe. The general trend, however, seems to be toward a more complete treatment of the wastes as time goes on. Thirty or forty years ago in England many of the so-called sewerage districts were organized under acts which were exceedingly liberal in their viewpoint toward the manufacturer. Under the old River Pollution Prevention Act (1876), the local boards were required to have regard to the industrial interests in the case and the circumstances and requirements of the locality. It is not clear how far the individual conditions were to govern nor the costs of treatment. To-day however, the English practice has swung the other way, under more recent statutes, the manufacturer being required to do more and more. In the decision concerning the Tanworth, Birmingham and Rea Drainage Board, 1909, the Court took the position that sewage treatment should be sufficient to make the effluent as good at least as the character of the stream. This has been taken by some as an index for treatment of industrial wastes. In the specific case of Gloversville, N. Y., the standard adopted required the effluent from all tanneries to be at least as low in content of suspended matter as the city sewage before such wastes were discharged into the sewer, the final treatment being given in municipal works. In other cases, the requirement of a non-putrescible effluent has been made, where conditions of stream pollution controlled.

Remedial Measures

Remedial measures in general may be based on

1. The reduction of the volume of the wastes as much as possible, except where dilution is helpful in promoting ease of treatment.
2. The discharge of wastes at low rates, continuously, instead of in sudden outflows.
3. The provision of screens, either coarse or fine or both. Where more material must be removed, settling tanks, either alone or combined with screens, may prove useful, arranged for the convenient removal of the sludge. These details depend on the industry.
4. The provision of further treatment, either separately or mixed with the domestic sewage, according to accumulation. Under this head would come the use of all kinds of biological treatment, intermittent sand filters, sprinkling filters, activated sludge and the like.
5. The elimination of the waste by evaporation. This has been done on a few wastes where the value of recovered material proves worth while.

In particular a few typical industries may be cited:

Tanneries

Preliminary settling is helpful either in hopper-bottom tanks or possibly in shallow tanks of the Dorr type. The sludge may be drained on sludge beds. The treatment must be adapted to the processes used in the tannery. Activated sludge has been used with success in an experimental plant. Other biological processes are adaptable.

Packing Houses

Preliminary screening is decidedly helpful in removing solids. The skimming of grease is also essential. Further treatment may be had in settling tanks, but the most promising development appears to be in the activated sludge treatment. This will give a high-grade effluent, if desired, and a sludge which can be recovered in all probability at a cost which is less than the value of the dried sludge as a fertilizer.

Canneries

Careful study of the processes may show means of holding back material. Pulp and other refuse should be treated as garbage, instead of dumping into the sewer.

Treating Industrial Waste and Sewage Together

From the standpoint of the smaller town called upon to treat its own sewage for the purpose of avoiding stream pollution, the question of receiving industrial wastes into its sewers or plant becomes of considerable importance. Foremost is the question of cost. Not alone may the first cost of the plant be increased by the presence of wastes, but the operating costs may be increased. Certain classes of wastes tend to interfere with the successful working of biological treatment, and in at least one case (Hudson, Mass.) where wool-scouring wastes were discharged into the city sewers, the effect was so pronounced that they were ordered out. In another case for instance, Worcester, Mass., with acid sewage from wire mills, special treatment with lime is required.

Division of Financial Burdens Is Difficult

To the city official the division of financial burdens appears very puzzling at times. On one hand may be a large corporation paying a generous proportion of the taxes, and yet on the other creating a serious condition of nuisance which demands relief. This phase of the situation has developed further in England where the concentration of industry and population on small streams early produced intolerable conditions. The situation there has been complicated by certain technicalities arising when the wastes are discharged into municipal sewers. In many cities in England manufacturers desiring to discharge their trade wastes into the municipal sewers try to come to an agreement with the municipal authorities. Such agreements usually bear in mind the removal of suspended matter, floating matter, etc., and the removal or treatment of all constituents which will put additional burden on the municipal works in dealing with the mixed sewage. The practice is very varied. In some of the cities the waste is received after preliminary treatment, and when mixed with domestic sewage handled without charge. In Salford, for instance, the corporation undertakes to remove and dispose of any sludge collected in any preliminary treatment works free of any charge to the manufacturers. In other cases the industrial waste is received into the sewers without any preliminary treatment on the condition that the manufacturers pay the increased cost of the treatment works or the increased cost of operation, or both. On the other hand, outside large manufacturing centers, occasionally manufacturers are allowed to discharge trade wastes into the sewers without agreement and without charge or preliminary treatment. Changes in the laws were expected following the final report of the Royal Sewage Commission.

Burden of Cost on Manufacturer

In the United States, as in England, where wastes are discharged into a stream the burden of cost has generally fallen on the manufacturer making the waste. Where the wastes are discharged into a sewer system, preliminary treatment has generally been required, as noted, or occasionally

complete diversion, and separate treatment. The question of additional cost of further treatment has been regarded as a problem for local adjustment.

Lines of Preliminary Action

To aid in the study of the industrial waste problem, certain lines of preliminary action are helpful. The municipality should keep a record of all sewer permits, the industrial permits being classified. Further, each industry of size should be required to have as few outlets as possible, each provided with a manhole, readily accessible for inspection, sampling or measuring the flow. Where doubt is had as to the effect of an industry, competent expert advice should be secured, and suitable methods planned to overcome the difficulties. In some cases recommendations cannot be made until after extended study, and perhaps tests.

Importance of Tests

The importance of carefully executed tests on industrial or mixed sewages should not be overlooked in planning sewage treatment works, particularly where the methods of financing preclude any flexibility or quick increase in the size of the plant, if conditions demand later. Such tests are not so expensive as to be prohibitive for the smaller towns. There is usually little need of following the elaborate program of some of the large cities. The author has run special tests on removal of odors, from drinking water with apparatus costing as low as $500. But for any conclusive sewage treatment studies, from $1,500 up should be available for constructive purposes, in normal times. Under present conditions higher figures are necessary. The costs of operation will vary widely with the amount of waste and scope of the inquiry. Some of the smaller cities have spent the amounts in preliminary tests, shown in Table I.

TABLE I—COSTS OF SPECIAL INVESTIGATIONS ON WATER AND SEWAGE PURIFICATION.

Place.	Work	Date	Approximate Cost.
Waterbury, Conn.	Sewage.	1905-07	$14,000
Baltimore, Md.	Sewage.	1907-08	17,500
Oakland, Calif.	Water.	1907-08	19,390
Gloversville, N. Y.	Sewage.	1907-09	13,570
Akron, O.	Sewage.	1911-12	9,400
Decatur, Ill.	Sewage.	1914	5,500
Houston, Texas.	Sewage.	1915-16	5,524

Tests seem particularly necessary at present on the groups of wastes which are or by their fermentations tend to become acid,—such as the water from dairies, beet sugar works, corn products works and the like. The application of activated sludge to industrial packing house treatment requires careful attention, as the processes in different houses vary, and the character of the water used also appears to have an influence, particularly in the sludge treatment.

Successful Ultra-Violet Ray Sterilization of Henderson, Ky., Water Supply

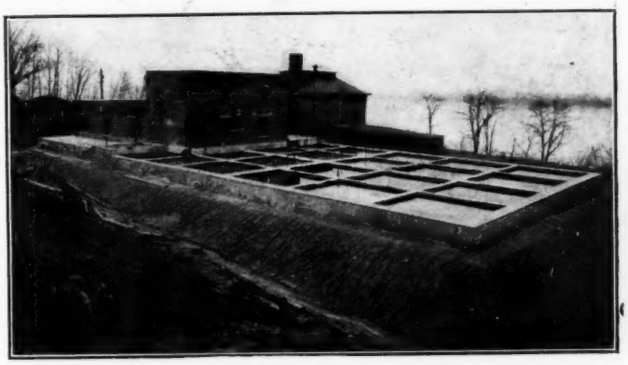
At Henderson, Kentucky, sedimentation, coagulation and mechanical filtration are followed by ultra-violet ray sterilization and this treatment of the public water supply has been in successful operation for several months. The large, pressure-type ultra-violet-ray sterilizers in operation at Henderson, and here illustrated, are the first of this type designed for use in a city water purification plant. The sterilizer units are automatically operated. The illustrations and information relative to this plant were furnished by A. T. Smith, President of the R. U. V. Co., Inc., of New York City, who furnished and installed this sterilization apparatus.

Elements of the Plant.

The City of Henderson, Ky., located on the Ohio River about 12 miles below Evansville, Ind., secures its water-supply from the Ohio River. It has a population of about 17,000. Up to 1916, untreated water was pumped to a 4,000,000-gal. reservoir. The storage was equivalent to less than two days' supply, the average daily consumption being about 2,500,000 gals. The City, after considering various schemes, finally acepted the joint proposition of the R. U. V. Co., of New York City, and the Pittsburg Filter Manufacturing Co., of Pittsburgh, for a complete sedimentation, filtration and sterilization plant at the pumping station site to have a nominal capacity of 3,000,000 gals. per day and designed to be increased to double that capacity without affecting the present structures.

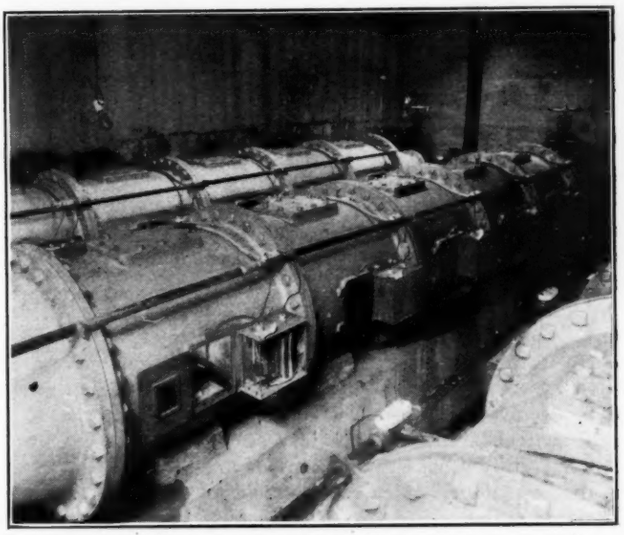
Design of Plant

The design was passed upon by J. W. Ellms, consulting engineer, Cincinnati, Ohio. There are two coagulating basins, each 95 ft. long, 30 ft. wide and 15 ft. in depth; and two



VIEW OF WATER PURIFICATION PLANT, HENDERSON, KY., WHERE SEDIMENTATION AND MECHANICAL FILTRATION ARE FOLLOWED BY ULTRA-VIOLET RAY STERILIZATION.

baffled mixing chambers, 7½ ft. wide, 25 ft. long, and 17½ ft. in depth. The detention period in the coagulating basins is 4 hours on a capacity of 3,750,000 gals. per day, and the capacity of the two settling basins is 620,000 gals. Six reinforced-concrete filter units were installed, each 17 ft. long by 13 ft. 4 ins. wide, with a normal capacity of 625,000 gals. each, totaling 3,750,000 gals. per day. The filters are of reinforced-concrete throughout, with a brick building covering the filters and the head house. A clear-well covers the entire area below the fil-



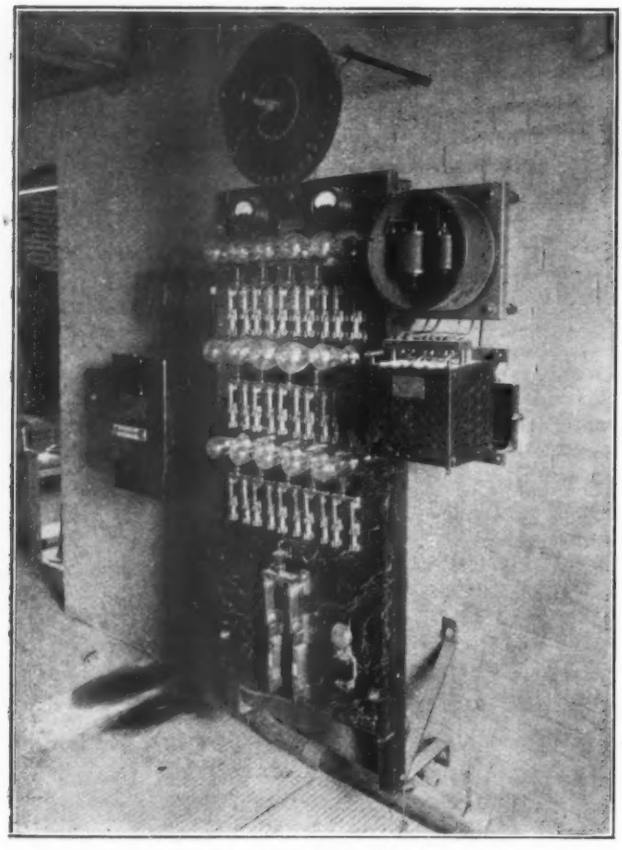
ULTRA-VIOLET UNIT OF LARGE SIZE USED IN HENDERSON, KY., WATER PURIFICATION PLANT.

ter units and pipe gallery. Adjacent to this on the outside, is a low re-inforced-concrete building, 17 ft. wide by 28 ft. long, in which is placed the ultra-violet-ray sterilization apparatus.

The Sterilizers

The ultra-violet-ray sterilizers consist of three legs, each comprising five units. The legs are connected in parallel, while the entire equipment is connected in series with the pipe

line leading from the clear-water basin to the sump from which the pumps draw their supply. Valved increasers and reducers are provided to connect the sterilizer with the service pipe line, as the sterilizer units are made 30 ins. in diameter to secure low velocity. Each unit has a lamp box inserted in its side, equipped with a clear quartz closed-end tube, which projects into the body of the unit and around which the water is forced to flow in a thin film, by means of a baffle placed at 90° to the long axis of the sterilizer. The baffle has a slotted opening to receive the quartz tube and to provide for passage of the water.



OPERATING AND INDICATOR BOARD, HENDERSON, KY., ULTRA-VIOLET STERILIZATION PLANT.

Inside the quartz tube is placed a 220-volt direct-current mercury-vapor arc lamp. It is properly held in place and automatically tilted by a special support which is located in the lamp box.

An iron baffle place with four large holes is inserted in each unit to insure bringing each particle of water into the field of the ultra-violet rays during its passage through the apparatus. Each lamp is provided with a small individual switch cabinet to provide proper electrical starting characteristics. A main switchboard is also provided and placed adjacent to the filter-operating room. This board has mounted on it a tell-tale incandescent lamp for each ultra-violet lamp in the sterilizer, main-line switches and indicating instruments. There is also a warning bell which rings when a tell-tale lamp is lighted.

If any ultra-violet lamp fails or diminishes in power from any cause, the bell rings and the tell-tale lamp on the main switchboard shows which lamp or lamps in the sterilizer are in trouble. A motor generator set is provided to transform the available alternating current into 220-volt direct-current.

Table I gives results taken from daily tests run continuously for over two months and are offered to indicate the effectiveness of the sterilizer. The bacteriological work was done in accordance with standard methods of the Laboratory Section of the American Public Health Association, and the average results were closely checked by the maximum and minimum obtained, which vary little from average results.

TABLE I—TYPICAL RESULTS OF TWO MONTHS' TESTS ON EFFICIENCY OF STERILIZATION BY ULTRA-VIOLET RAYS AT HENDERSON, KY.

		Bacteria per c. c., 24-hr. Incubation			
	Total No. of	Total Bacteria		B. Coli	
Sample	Samples	Maximum	Average	Maximum	Average
Raw	25	190,000	85,000	1000.0	276.0
Coagulated	25	1,200	720	100.0	45.0
Filter	70	320	80	1.0	0.035
Leg 1:					
Influent	52	95	32	1.0	0.260
Burner 1	48	30	16	0.8	0.215
Burner 2	48	20	8	0.8	0.200
Burner 3	48	16	6	0.2	0.136
Burner 4	48	6	2.10	0.1	0.090
Burner 5	54	3	0.31	0.0	0.000
Leg 2:					
Influent	53	75	36	1.0	0.310
Burner 1	47	50	12	0.6	0.273
Burner 2	47	20	6	0.8	0.18
Burner 3	47	7	5.20	0.4	0.117
Burner 4	47	6	1.80	0.1	0.07
Burner 5	54	3	0.38	0.0	0.0
Leg 3:					
Influent	54	95	25	1.0	0.326
Burner 1	47	55	14	0.8	0.240
Burner 2	47	19	9	0.8	0.21
Burner 3	47	12	4	0.4	0.110
Burner 4	47	6	1.60	0.1	0.06
Burner 5	54	3	0.42	0.0	0.0
Tap at pump...	34	11	0.39	0.0	0,0

The plant was put in operation toward the end of 1916 and has since run under a varying capacity from 2,200,000 to about 3,500,000 gal. per day. The current consumption guarantee of 0.77 per lamp was met in operation. The cost of final sterilization by this method can be estimated from the current consumption, which is 92.5 kw.-hr. per 1,000,000 gallons.

Rate of pumping 2,200,000 gal. per day to 3,200,000 gal. per day, with little or no variation in results.

Turbidity of raw water varied from 130 to 880 p. p. m.

Filtered water usually clear with maximum turbidity of 5 p. p. m.

Performance of a 2½-Ton 6-Cylinder Motor Truck

Two years ago a manufacturer of heavy machinery purchased a 2½-ton, 6-cylinder, worm drive truck which has made a fine performance record. The truck has no vibration, due to a 6-cylinder motor, a worm drive making a smooth and easy running truck. The truck is also easy riding due to semi-elliptical front and rear springs 2½ ins. wide and 60 ins. long. This truck is being used to haul freight to and from depots, and to haul castings from several local foundries. The truck makes four to five trips a day, always carrying capacity loads and sometimes over. The daily average run is from 60 to 70 miles, and the truck makes from 8½ to 9½ miles per gallon of gas and per quart of lubricating oil. The truck easily negotiates steep grades without shifting to intermediate gear. The truck under discussion is a Stegeman, equipped with an electric starter. This starter saves both truck and driver time, by eliminating hand cranking. The truck stops 40 or 50 times each day, and figuring 1½ minutes for cranking, the starter easily saves 50 minutes of the driver's and truck's time each day. The users, the Pawling & Harnischfeger Co., of Milwaukee, figure also a saving of 75 cents per day on gasoline due to the economy of the truck's operation.

WATER WORKS DESIGN AND CONSTRUCTION

Practical Hints on Various Features of Water Works Design

By J. W. Ledoux, Water Works Engineer, 112 North Broad Street, Philadelphia, Pa.

In such strenuous times as we are now passing through, the engineer having in charge the design and construction of water works under various conditions finds his viewpoint and standards subject to modification and uncertainty. What was practical a year ago is now impossible; he hesitates to specify this or that for fear that it cannot be obtained—the price may be changed over night or the government may commandeer everything connected with it. Manual labor of all kinds demands from two to four times the wages heretofore paid, and even then men cannot live as well as before on account of the high prices of supplies. People are beginning to cut down expenditures for luxuries and even for necessities, so that with all the extra demands for war supplies, industries are at any moment threatened with panic. Water works construction, then, necessarily is limited to improvements that are essential.

Influence of Present Conditions

Storage Requirements.—In the past, conservative engineers, when designing gravity supplies, provided sufficient storage to produce an ample supply during periods of the worst drouths on record. Today such reservoirs as they have are given credit for a supplying capacity such as will take care of the needs during average periods, and the engineer trusts in Providence to take care of him until normal times return.

Pumping Machinery.—The same principle is adopted concerning the pumps and boilers; if the demand for water increases, they are run to the limit of their overload capacity.

Filters.—Nowadays nearly all filters are mechanical, the slow sand type being what we might call a "back number." The rating of these mechanical filters is normally about 2 gal. per square foot per minute, but to take care of the peaks and maximum demands they are easily pushed up 50 per cent., and in some cases, especially with pressure filters, to 100 per cent. above their standard rating. The quality of the water may suffer, but the operators either take chances, depend upon chlorine, or once again upon the kindness of Providence, and thus it is all through. Expenses of operating the water works have increased like every other commodity, but the income cannot rise, because the rates are fixed by recently established tribunals, which act with extreme slowness and uncertainty, and so the water works managers can struggle along with inadequate service and on the ragged edge of accident and total disability. If the dreaded event takes place, and the public thereby suffers, the blame is placed on the "villians" who own the water works, and not on the system by which they are hamstrung.

Under these conditions the science of design and construction of water works cannot be approached with that broad spirit of substantiality that was heretofore the practice. Nevertheless, engineers cannot afford to allow such lowering of their standards to become a confirmed habit, and it is to be hoped that the conditions of the past, wherein the practice which was recognized to be the best, will soon be restored. In the meantime, as far as the war is concerned, our country demands our absolute loyalty and hearty co-operation.

Vital Elements in Water Works Design

The vital elements upon which the design of a water works depends may be given in the following order:

1. Financial consideration. 2. Water supply. 3. Means for supplying water from source into the distribution mains. 4. Distribution system.

The financial consideration involves the following questions:

1. How much income can be depended upon? 2. What will it cost to install the system? 3. What will it cost to operate it?

The first financial question is independent of the others, but the second is dependent upon the first, and the third upon the first and second; although, looking back over plants which have been in existence for a generation or more, we often wonder whether the projectors had much regard for financial considerations.

For the past five years it has been impracticable to float a water works proposition that did not show with a fair degree of certainty earnings in excess of 50 per cent. over the operating expenses, depreciation and interest on the cost.

In the past times—fifteen to twenty years ago—the formula was something like this: "People must have water; American communities are sure to grow, and even if we have to carry the works for one or two decades, we must eventually make a handsome profit on the entire investment."

As a consequence, villages and hamlets secured city size water works and were enabled to develop and grow by reason thereof. When they grew up to be a municipality or city they often forgot the utility which made their growth possible, and exerted themselves to discredit and depreciate their water works, knowing they were now able to build their own plants.

This attitude gave rise to the numerous devices for regulating rates by the municipalities, commissions, etc., so that the dreams of ultimate profit by the water works owners were seldom realized. Today no one in the least posted in water works finances would dare undertake the installation of a water works proposition unless the financial success of the venture were absolutely assured.

Sources of Water Supply

The water supply falls into many natural subdivisions. It may come from rivers or lakes, from springs, from the natural flow of streams, from storage reservoirs which equalize the flow of streams, from shallow or deep wells, or from the salt sea.

Rivers and Lakes

The difficulties and risks involved in the other sources are so great that many very good engineers prefer to obtain the supply from large rivers or lakes. There is much to be claimed for this practice. Usually the water from this source is of unsatisfactory quality, without complete purification, but the one vital question of adequate supply has been settled for all time, and its purification is only a question of well-known mechanism, chemicals and attention at a not prohibitory expense.

Springs

Although many water works report them as such, there are comparatively few plants whose supplies come from springs. As far as quantity is concerned, a town or city is fortunate to possess this kind of supply, because the flow usually fluc-

tuates little and the quality of the water is constant. In most cases, however, the water is notoriously hard, as the supply generally comes from subterranean sources, through fissured or cavernous limestone formations. A few notable examples are: Boiling Springs, near Carlisle, Pa., flow nearly 20,000,000 gal. per 24 hours; Roaring Springs, above Hollidaysburg, Pa., 6,000,000 gal.; springs supplying Bellefont, Pa., Bristol, Tenn., Roanoke, Va., 7,000,000 gal. per day; Jacksonville, Fla.; Phillipsburg, Pa., water works; Allentown, Pa., water works; Bethlehem, Pa., water works; Bennetts Springs, the head waters of Niangua river, Missouri, flow 170,000,000 gal. per 24 hours, and Hahatonka Springs, farther down on same river, flow 160,000,000 gal. per 24 hours.

With the exception of Phillipsburg, Pa., which is clear, soft water, in every one of the above cases, and there are many more, the water is clear, comes out of limestone formation, is quite hard and maintains a fairly steady flow.

Streams

When a stream is large enough without storage to afford a reliable and steady supply for a large town, it practically comes under the category of a river. The engineer, however, must be on his guard, because the past records of flow may be unreliable and not sufficiently prolonged to cover such extremes of flow as occur and are vital to the success or failure of a water works. The most important considerations are a study of the rainfall and its distribution, the drainage area, and, lastly, stream measurements, if such be available. If not, an actual gaging should be made to obtain the daily, weekly or monthly flow from one wet season to the next, coincident with the rainfall. Then calculate the flow for the critical cycle of years by the unsurpassed method described by Vermeule in "Water Supply," New Jersey Geological Survey, 1894.

Storage

In order to make any satisfactory estimate of the storage required to insure at all times a given yield from a known drainage area, it is first essential to have a diagram of the monthly flow covering a period containing the cycle of lowest flow which is likely to be experienced. With such data there can be prepared a mass diagram, which consists in plotting the total flows up to the end of each month. For instance, if the flow in inches per square mile for the four years up to June 30 were 40 in. and the flow in June were 2 in., July 1.50 in., August 0.75 in., September 0.30 in., the plotting would be: June, 42; July, 43.50; August 44.25, and September, 44.55 in.

We can plot on the same diagram in the same way the total estimated consumption, or "draft on storage." The maximum distance between these two diagrams will be the storage required.

The preparation of such a table involves much time and labor, but the information is invaluable, and a dozen or more well distributed over the country forms an essential part of the equipment of the experienced water works engineer.

Limitations of Storage Tables

It is, however, not safe to use these tables with confidence that they will apply perfectly to other streams having apparently similar physical conditions. For instance, there is a vast difference between the Perkiomen and the Tohicken creeks. In Dauphin county, Pennsylvania, there are three parallel streams—Stony creek, Clarks creek and Powells creek. Their watersheds are similar in size and geologically. Stony creek has very little forest as compared with the others; Clarks creek and Powells creek are similar in that respect. Clarks creek and Stony creek have very similar characteristics of flow, but the dry season flow of Powells creek is only about half that of Clarks creek for the same unit of drainage area. Similar discrepancies are encountered all over the country, so that the engineer has to be very careful in applying the results of one drainage area to that of another one, although similarly situated; that is the reason why one season's gagings of the stream itself is of vital importance to arrive at the characteristics of flow.

It is well here to offer a word of caution concerning the published records of stream flow. While much of it is authentic and reliable, such, for instance, as the Sudbury, Croton*, Perkiomen**, Neshaminy**, Tohickon** and many streams, especially in the arid region of the west, still there is a vast amount that is misleading and dangerous in the hands of men having implicit faith in its reliability. That is why a proper study of the rainfall, which is usually reliable, is of great value as a check.

Stream Gaging

Where it is desired to gage a stream the writer recommends for small streams the use of weirs; for large streams and rivers either pitot tubes or current meters, but if the stream is turbulent and fluctuates in flow from moment to moment, the current meter should be extremely well made and have its moving parts as light as possible, so as to avoid inertia and consequent over-registration. Otherwise there is a possibility of 25 to 50 per cent. error.

The chemical method of gaging is occasionally applicable, but for large streams is very expensive and difficult of application, and unless every possible check is applied the results are uncertain. Under suitable conditions it is the most accurate method ever devised. The ideal situation for its adoption is a rapidly flowing, turbulent stream, with a bridge over a narrow section at the applying station and a bridge at the sampling station down stream.

Well Supply

Many important water works obtain water from either shallow or deep wells. In most of these cases the water is of excellent quality and really safer from a sanitary standpoint than any system of filtration or purification. Many people have an idea that artesian wells can be sunk anywhere and provide an ample supply of good water. That, of course, is not the case; where the geological formations are below the sedimentary rocks artesian wells will yield too little water to be worth while. In many of the upper formations the water is so charged with iron, sulphur, soda or other chemicals as to be unfit for use. Even where the rock formations are suitable the success of the well is problematical. In arid countries, like parts of Texas, New Mexico, etc., they afford the only possible and practical supplies. Those supplies which come entirely from flowing wells are so rare as to be hardly worthy of consideration. Shallow wells have their application where there exists within 50 ft. of the surface a bed of coarse sand or gravel tributary to a large drainage area, or where these porous strata are along the bank of a river or lake.

Frequently this kind of supply diminishes in available yield, probably due to the closing up of the strata by the process of filtration, so that most water works which originally adopted shallow or infiltration wells eventually abandon them and either obtain a new supply or go directly to the river which was supplying the infiltration water.

The science of wells is vast, interesting and complicated, and an instructive and practically useful history could be written concerning every such single plant in the country.

Sea Water Supply

There are few situations in the United States where some kind of a fresh water supply is not available. Along the southern Atlantic coast there have been salt water tidal streams dammed and thereafter successfully used for a water supply. The city of Norfolk, Va., and the city supply of Charleston, S. C., afford good examples. In the latter case a

*The drainage area of Croton, as published, is said to have a material error.

**The reliability of the stream flow records has been questioned, but the writer believes the data can be taken as approximately correct.

tidal stream draining about 50 square miles was dammed at a point on the tidal salt marsh about six miles down stream from permanently fresh water. When the dam had been completed the contents of salt above the dam were about 1,000 parts per million, but in two months, by the aid of a centrifugal pump and the natural fresh water dilution, the salt was reduced to a hundred parts per million, and in two years, without other assistance than the regular pumpage of water at the rate of about 3,000,000 gal. per day, the content of salt was reduced to fifteen parts per million, which was the normal salt in the fresh water portion of that stream. The experience of the city of Norfolk was similar. It may be remarked in passing that when the content of salt is over 800 parts per million it is readily perceptible to the taste, and when it is below 150 there seem to be no bad effects of any kind from its use.

Where it is necessary to take the water directly from the sea or from a supply which cannot be diluted sufficiently with fresh water, the only practicable plan is to distill the water. Ordinarily 1 lb. of coal will evaporate and distill from 6 to 10 lbs. of water, but by the well-known multiple process 1 lb. of coal will readily distill 25 lbs. of salt water, and in extreme cases up to 50 lbs.; so it is commercially practicable to furnish a city water supply even when only the ocean is available, provided the citizens are willing to pay $2 per 1,000 gallons, which, after all, is not a high price for such precious fluid.

Means for Supplying Water Into Delivery Mains

These consist of the intakes, head works, dams, pumping and filtration plants and delivery mains. To discuss these in all their ramifications would require a volume, but a few hints under each heading may be of interest.

Intake Pipes

In a lake supply the intake pipe is usually carried out far enough to reach a depth below grounding ice—from 15 to 40 ft. This is also necessary to get beyond shore contamination. If the lake be navigable the intake crib as well as the pipe itself must be protected from dragging anchors. Therefore it is necessary to lay most of the pipe in a trench. To make the joints tight the services of divers are necessary. There are few, if any, divers that can make up the joints in all cases water-tight, so, in order to repair such leaks as occur, it is very necessary that the pipe be tested at intervals by plugging the unfinished end and pumping air into the pipe. If the lake is not too rough the leaks can readily be located by the air bubbles. Finally, the extent of the leakage can be determined volumetrically by means of a barrel or tank from which water is emptied through a small pipe into the shore end of the intake pipe. It is unnecessary to say that these intake pipes should be laid at every point with either an ascending or descending and perceptible grade, so as to avoid air pockets.

Intake Towers

In large reservoirs intake towers are considered the best practice, as they readily enable the water to be shut off, or screened, or taken at any desired level, by providing valved openings at the necessary elevations in the tower. In rare cases this latter object has been accomplished by a swinging intake pipe, the inlet end being supported by a large float, which maintains the opening of the pipe at a constant depth below the surface of the water. The average water works has neither tower nor swinging pipe and takes the water at a constant level near the base of the dam.

One of the most troublesome situations is to provide satisfactory intake works for a river like the Ohio, subject to a rise in many places of more than 60 ft. There have been numerous devices used with more or less success, one of the most novel and probably troublesome being the slope railroad, on which is located a car containing the pumping engine. On the side of the track is located a steam pipe, discharge pipe and suction pipe, running down the slope to a point below low water, each having at suitable intervals the necessary openings with which to connect the pump by means of flexible sections of pipe at the various stages of the river.

The best practice, however, is to locate the pump at the base of the inside of a permanent water-tight well, or tower, whose bottom extends down a little below low water. A perforated suction pipe extends out into the river, and suitable connection is provided in the tower for flushing out this suction pipe with high-pressure water. To be safe, the pump and suction pipe must be in duplicate. Usually these pumps are low-service and pump to a sedimentation basin, from which the water gravitates through the filters to the clear reservoir, from which it is pumped by the high-service pumps into the service or into the distribution reservoir. To save cost, in some cases these towers may be built parallel to and just below the slope of the river bank.

Concrete Dams

The preferable construction in any important case is undoubtedly the masonry or concrete gravity dam. The base should be in width 70 per cent. or more of the height, and the down-stream toe should be 5 ft. or more below the surface of the solid rock against which it rests to prevent sliding. A narrow cut-off wall should extend under the up-stream toe down to practically impervious material. As most of the important failures of masonry dams have undoubtedly been due to undermining by erosion or to sliding and not to overturning, the greatest care should be taken to avoid these weaknesses. Much has been said about upward pressure, but the writer never thought this of much importance, because it is so easy to eliminate it by making porous and draining the entire base of the dam down stream from the cutoff wall and without diminishing the strength or adding to the expense. However, if the above proportion and precaution are adopted no further provision need be made, except to build it of the conventional shape, and of excellent material and workmanship.

Earth Dams

The next best dam is of earth. But to insure safety, requires ability, great care and the observance of several important elements of design. The first requisite is a cut-off trench deep enough below the natural surface and properly filled with water-tight material to prevent percolation under the dam.

The second requirement is that the whole of the dam material be deposited wet in thin layers (6 in.) and thoroughly compacted by heavy steam grooved roller, selecting the best material for the upstream portion and incorporating it with the material of the cut off trench. Third, the slopes must be protected from erosion. Fourth, an ample spillway, generally capable of discharging at least 250 cu. ft. per sec. per sq. mile of drainage area must be provided, and preferably constructed on the natural material at one end of the dam, and have its channel carried down to the stream.

The writer favors a completely unrestricted spillway rather than to place dependence on mechanically operated gates. The construction of earth dams cannot be too carefully inspected by men who know and observe the necessity of constant care.

Several important earth dams in the east and numerous ones in the west have been built by the hydraulic process. In some favorable conditions this method results in economy, but in the cases the writer has observed in the east, neither the economy nor the safety has been materially improved.

The hollow reinforced concrete dam has been developed within recent years, and at first seemed to possess much promise, but there have been so many failures and disappointments in the results without any material saving in cost that the plan has lost much of its popularity.

Choice of Pumps

The type of pump to adopt depends somewhat on the locality. Undoubtedly the most popular is the direct-connected electrical motor driven volute type of centrifugal pump. In fact, the wise manager will adopt this outfit even when he knows the total annual cost will be as great as with the best other installation he can make; and many people adopt it even when the annual cost is from ten to fifty percent greater. The popularity is due to quiet running, simplicity, small space, freedom from water-hammer, low repairs and the elimination of fuel and fire difficulties. The apparatus is more nearly standardized, the pumpage can be readily metered, the electrical current can also be readily measured, so that the entire mechanism is neat, scientific and good to look upon.

However, when the price of electricity is more than ¾cts. per k. w. hour, the economy can be surpassed by steam, where fuel does not exceed $4.00 per ton.

When we get away from electricity we come to the direct-connected steam turbine driven centrifugal pump, which competes with the cross-compound condensing Corliss pumping engine, the latter being higher in duty but nearly double in cost of installation. To get reasonable duty the steam turbine plant must have a condenser producing 27 to 28 ins., while the fly-wheel steam engine produces a good duty with only 26 ins. vacuum. Under favorable conditions the steam turbine pump gives a duty of 110,000,000 while the steam engine pump produces 140,000,000 duty.

It is seldom that where any real attempt is made to get the best economy of operation a direct-acting compound condensing or even triple expansion pump is nowadays installed, but in the west American-made Deisel oil engines are frequently used. They will produce a horsepower on less than half a pound per hour of any kind of fuel in use. The engine can either be geared or belted to a reciprocating power pump or a centrifugal pump.

The producer gas pumping engine is not now so popular as it promised to be ten years ago. Probably that is because the producers are not readily adapted to different kinds of coal, and while the station duty is about as high as with the best steam plants under proper conditions, it is not easy to maintain these conditions.

In the boiler field no material advance has been made in the last ten or more years, except that automatic stokers, overloading and superheating have become more general.

Well Pumps

The air lift still affords the most popular method of pumping from artesian wells, where the water stands below suction distance. It is notoriously inefficient but easy to handle and lifts more water from a given well than any other method.

Where electricity is available at a reasonable price a vertical shaft motor driven multi-stage deep well turbine pump is the best and most economical installation and will produce an efficiency of over 50%, while the air lift gives less than 20%. These pumps can be so installed as to pump with the same motor the entire supply at once into the system under full waterworks pressure. The direct-acting deep well plunger pump is now seldom used in first-class practice.

Filters

Today the standard plan is mechanical filtration—generally of the open rectangular gravity type usually in half million or million gallon per day units. Each unit is provided with a simple rate controller, rate of flow and loss of head gauge. In the best plants these are recording gauges.

The strainer system of the filters are of various types, all of which have more or less merit. Probably the simplest and about as satisfactory as any, consists of a manifold and transverse pipes, 6 or 8 ins. apart with ¼ in. openings pointing downwards and spaced 6 or 8 ins. apart. On these iron pipes is laid graded gravel to a depth of say 18 ins. and thereon a layer of 2½ ft. to 3 ft. white silica sand between No. 15 and No. 30 mesh. The walls and bottom of the filter are of reinforced concrete preferably, but sometimes of iron or even wooden plank.

A wash water tank 20 or 30 ft. above the filters is desirable, and the washing system should be designed to wash at a rate of 15 to 20 gals. per sq. ft. per minute. At this rate air or mechanical agitation is unnecessary.

A sedimentation tank or reservoir holding not less than three hours and not necessarily more than 24 hours supply is essential. Into this the sulphate of alumina is fed at a uniform rate about as near proportional to the consumption of water as convenient. In some cases this basin has directly connected with the suction pipe a small compartment into which a portion of the coagulant is fed, with the idea of getting a better floc for the filters. Generally, the one large basin is all that is necessary to operate.

It has been found within the last ten years that the alum sulphate can be automatically fed at a uniform rate dry with far less difficulty than by making solution mixtures as heretofore.

Chlorine

In all first-class purification plants provision is made for sterilizing the filtered water by either liquid chlorine or by hypochlorite of calcium, the former being the most popular at the present time.

Some managers have the system designed so this chlorine will automatically feed in proportion to the consumption of water, but where there are attendants available, hand control will give just as satisfactory results, especially where it is fed into the clear water reservoir.

Lime or Soda

The complete treatment of a highly colored water often requires lime or soda ash to produce sufficient alkalinity to neutralize the sulphuric acid of the alum, but often times the color must be removed first by alum sulphate and the lime added later. Otherwise the color will be set and cannot be removed at all.

Laboratory

Every plant has its own particular water treatment, and therefore a neat laboratory forms an essential part of every filter plant. In it there is provision made for determining the number of bacteria, the presence of B. Coli, the alkalinity, turbidity and color—all simple tests that anyone can readily learn without previous technical education.

Supply Mains and Distribution System

For low pressure large conduits are now made of cast iron, reinforced concrete, steel, wood or terra cotta. Cast iron is the standard construction, but reinforced concrete. when made and laid according to the best modern practice, seems to be the most practicable for low pressures, say from 10 to 50 ft., because it does not corrode and maintains its carrying capacity indefinitely.

Steel pipe is used in the west on account of the expense of transporting cast iron. In the east it has not been extensively used for water conduits, and in some of the most important cases where it has, the results have not given perfect satisfaction. Too much dependence must be placed on the coating, and no one as yet has discovered a satisfactory coating.

Wooden pipe has its field, but the conservative engineer will only use it where any other kind would be prohibitive in price. A 24-in. wooden pipe has 2¾ times the capacity of a 16-in. cast iron pipe and costs about the same money in normal times, so the temptation to use the wooden pipe is great. If it must be used it is important that the quality of the wood be subject to rigid specifications. "Prime inspection" is none

too good a quality. It is also important that the pipe be laid under such conditions that it be always saturated by means of sufficient internal pressure. As the internal working pressure depends entirely on the distribution of the iron bands on the outside, it is important that these be thoroughly coated, so as to resist the corrosive effects of the soil in which the pipe is laid. If there is cinder or acid water, this kind of pipe should not be used.

No matter how well coated, cast iron pipe usually develops tubercles, which reduce the carrying capacity. The writer believes this condition to be more prevalent with soft than with hard waters, due to the presence of free carbonic acid in the former.

Pipe Flow Formula

Due to the presence of these tubercles, it is impossible to develop a pipe flow formula that can be counted on as correct except when the pipe is very new. One pipe will deteriorate 10 per cent. and another 70 per cent. in discharging capacity in twenty years' use under various conditions.

The Chezy formula is generally used, but many engineers prefer the Williams-Hazens formula, believing the results to be more accurate.

The former is, simplified:

Q=c d 5/2 power h 1/2 power divided by 1 1/2 power, in which Q=a unit of flow per unit of time, d=diameter of pipe, h=loss of head in friction, l=length of pipe, and c is a constant.

The Williams-Hazen formula is almost identical, but the exponents are sufficiently different to require logarithmic calculations in all cases. The authors have devised a special slide rule which makes the solution of the formula as easy as to use the common slide rule with the Chezy formula.

The writer believes that for cast iron pipe formula requirements are superfluous, for the reason that the flow is too much modified by the condition of the interior. A tuberculation amounting to only 3 or 4 per cent. by volume of pipe can reduce the flow more than 50 per cent.

Pipe Cleaning

Every up-to-date system of water works with cast iron pipe should possess pipe-cleaning apparatus. Frequent tests should be made by accurate pressure gages to determine the coefficient of flow, and if it is found materially less than normal the machine should be sent through the pipe. Pipes from 4 to 12 in. in diameter can be cleaned for about 10 cents per foot, and a very long, continuous line of pipe up to 24 in. in diameter can be cleaned for less than half that sum.

Street Piping

The engineer is obliged to fall short of ideal conditions in installing street piping. To install a perfectly adequate fire protection system would involve a constant pressure of 75 to 100 lbs. per square inch, at least ten hours' supply held in reserve high enough to produce that pressure, and mains large enough so that eight or ten 1¼-in. streams can be maintained under a nozzle pressure of 60 lbs. at any point of the system, while at the same time supplying the maximum consumption.

It is needless to say that there is not one water works in a hundred that reaches within gunshot of that ideal state, to accomplish which would be prohibitory in cost. Hence the public always finds little difficulty in pointing out the fire protection shortcomings of the water works.

The object is practically attained, however, by means of the elevated distributing reservoir or large standpipe, the fair-sized street pipes, the fire engines and the well-equipped paid fire departments.

Metering

Every important plant should be designed to include on the pumping or gravity mains either Venturi, orifice or pitot tube meters, and a sufficient number of these should be provided so as to enable a record to be kept of the distribution of flow into the important divisions of the system.

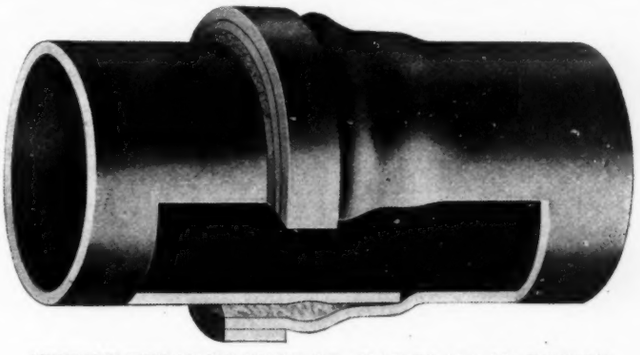
Recording Pressure Gages

For valuable information, as well as for the legal protection of water works owners, it is advisable to maintain one or more recording pressure gages on different parts of the distribution system.

The Use of "National" Matheson Joint Steel Water Mains

By F. N. Speller, Metallurgical Engineer, National Tube Co., Pittsburgh, Pa.

For about 30 years welded steel bell and spigot pipe has been used for water mains. For the past ten years most of this has been made with the expanded end known as the Matheson joint. Failures of the kind reported every week or so in the newspapers have so far been practically unheard of with this kind of pipe. This unbroken record of reliability is not affected by occasional leaks due to severe corrosion or electrolysis or collar leaks which occur also in cast iron or other pipe. Reliability in service is based on the large and uniform factor of safety especially against shock which obtains in this class of steel pipe. There are none of the hidden blow holes and other defects to be expected in cast metal. The foundation does not have to be so rigid. More power can



SECTION THROUGH JOINT OF "NATIONAL" MATHESON JOINT PIPE.

be safely employed in caulking and a much wider range of pressure can be safely carried in the same pipe compared with cast iron. Instances have been reported where this pipe has been permanently dinted and distorted by rock slides without leaking or interrupting service. For these reasons and considering the large saving in weight it is not surprising that Matheson joint steel has become so generally used in the mountain districts, said Mr. Speller in addressing the New England Water Works Association.

Each length of this pipe has a suddenly applied test pressure of 450 to 600 lbs. at the mill. This, together with the strain which is put on the weld, and material, when the bell is rolled out makes it almost a certainty that there will be no failures in service.

Carrying Capacity

Several tests have been run in service where cast iron and welded steel lines were conveniently located for this purpose, which proved the larger carrying capacity of the latter. This has been carefully determined on new pipe (4, 6 and 8 in.) in some elaborate tests under the supervision of the Underwriters' Laboratory, the results of which will be published in the near future. These tests indicate an increase in capacity of 20 per cent. in the steel over cast iron of the *same inside diameter*. As Matheson joint steel pipe is made to outside diameter and cast iron to inside diameter, the difference in favor of the steel on these nominal sizes is found to be 3 per cent to 4 per cent.

Durability

The service records covering the past 30 years also indicate less tuberculation on steel altho this trouble, like corrosion, varies so much with water conditions that it is difficult to make close comparisons. Durability is usually discussed in conjunction with strength and reliability in service when, as a matter of fact, they are separate problems which involve materials having widely different properties. Cast iron is necessarily made comparatively thick on account of the weakness of the metal and limitations involved in casting operations.

To take advantage of the lighter weight and greater strength of steel and at the same time increase the durability in service involves the use of a reliable protective coating. Much has been done along this line of late years, led by the demands of the oil and gas interests, where high pressure and consideration for safety have made welded steel pipe the standard.

Pipe Protection

Where conditions are very bad, as in tide water swamps, permanent protection has been obtained by boxing the pipe and filling in with 2 in. of well mixed concrete. While this has been proved satisfactory by 20 years' experience a cheaper and more flexible coating is usually all that is required.

Before any coating is decided upon, however, a careful survey of local conditions should be made to determine how much bad strata the pipe will pass thru. It usually turns out that only 5 or 10 per cent. of the system is exposed to conditions which might cause apprehension and such localities may be carefully protected without involving a considerable expense per foot over the whole line. However, it is safe to say that some protection should always be provided underground. This may be only a dip outside and inside in hot asphaltum of good quality. This acts as a good priming coat should it be thought advisable to add further protection. We advocate a wrapping of fabric saturated with a good quality asphalt pitch having a flow point of about 150 deg. F. Another layer may be applied, if necessary.

Application of Coating

Special machinery has been designed to apply this coating tightly and uniformly at the place of manufacture but if conditions warrant the coating may be applied in the field after cleaning and drying the line and applying a thin priming coat such as coal tar dissolved in benzol. The Standard Oil Company, of California, applies two layers of asphalt of high melting point to the cold pipe as soon as the priming coat is dry, which is covered spirally with a strip of burlap about 8 in. wide. Another thin coating should be applied to saturate and preserve the burlap. The writer has seen lines where the coatings so applied were ¼ in. thick on top and 5/16 in. underneath. These oil lines operate at 700 to 800 lbs. pressure. This would seem to be approaching the ideal system, where the pipe is strong and ductile enough to stand any reasonable amount of settlement or shock and where the coating is made of the material which experience has taught to be the best to withstand soil corrosion and electrolysis.

Inside corrosion of water mains has given comparatively little trouble; a properly applied dip has given all the protection required in the large majority of cases.

REFUSE COLLECTION AND DISPOSAL

Experience of Los Angeles with Cobwell Method of Garbage Disposal

The Pacific Reduction Co., of Los Angeles, Calif., has, for two years, been using the Cobwell system of garbage disposal and their experience with the method is summarized as follows by Howard Egleston, New Orleans, representative of the Cobwell system:

Lorin A. Handley, president of the Board of Public Work of Los Angeles, has written Mr. Egleston a letter, in which he says: "I do not hesitate to say this work is successful and satisfactory as a reduction method in every way—the most satisfactory I have ever known. Up to the present time we have never had a complaint registered by any citizen of Los Angeles."

The reducer, which is the essential feature, consists of a steam-jacketed, cylindrical steel chamber inclosing a rotary agitator operated by gears driven by motors. From five to six tons of garbage may be introduced into reducer. It is covered with cobolene, a form of naphtha or gasoline. Steam to a pressure of about 90 lbs. is admitted and the agitators are started, the reducers being tightly sealed. Vapors from the solvent and evaporating water pass through a pipe line to a condenser where the solvent is separated from the water, and returned to the reducer to be used over and over. The water is vaporized at a lower temperature when evaporated with the solvent, having a lower boiling point than otherwise would be required. This process completely dehydrates the garbage. A large amount of grease is liberated and is contained in the solvent. The mass is drained to a still, where the solvent is evaporated from the grease. By running more solvent through the mass the last vestige of grease can be recovered. The product free from grease and solvent is automatically emptied from the reducer to a conveyor, which moves it to a warehouse, where it is screened, ground and sacked, in appearance resembling ground coffee.

The Los Angeles plant gets about 630 pounds of the product from a ton of garbage. This is shown by analysis to contain: Nitrogen, 3.05 per cent; phosphoric acid, 1.96; potash, 1.22; crude fiber, 16.55; carbohydrates, 45.75; grease, 1.71 per cent; ammonia, about 3 per cent. The product is an excellent fertilizer. It also can be used as stock feed, and when soaked with water can be fed to hogs and other animals. The grease, of which each ton contains about 70 pounds, is valuable.

The reducers in Los Angeles not only dispose of garbage but of dead animals, and the product from carcasses is even more valuable than from the garbage, bringing last year $55 a ton as compared with $14 a ton for garbage, but of much greater value at this time.

In the Los Angeles plant about 660 pounds of steam are required for one charge consisting of from five to six tons of garbage.

The Los Angeles plant spends about $8,000 for water a year but in New Orleans the cost will be much less.

Los Angeles does not operate its plant. Its contract is that the Pacific Reduction Company pay 51 cents a ton for garbage delivered and dispose of private waste and dead animals at a fixed charge.

Mr. Egleston states that the high cost of gasoline will not affect the cost of operation to any appreciable extent because the gasoline or naptha used is condensed and used again and there is practically no waste.

Garbage Disposal by Dumping, Sanitary Fill, Burial or Plowing

Among the methods of garbage disposal in common use are: dumping, sanitary fill, burial and plowing. These methods are within the reach of small communities and such communities should note what the Springfield Bureau of Municipal Research, of Springfield, Mass., has to say relative to these methods.

Dumping on Land

The method of disposal of garbage by dumping on land, by dumping for sanitary fill and by burial or plowing into the soil are similar in many respects. Dumping on land, however, means simply the depositing of garbage on the surface of the ground without care to see that it is properly covered. Many cities dispose of their garbage in this way.

This method is most objectionable. It is difficult to find sufficient land suitable for dumps, especially when large quantities of garbage are produced. Offensive odors from fermenting and decomposing matter create a nuisance. When located in the outskirts of the city so that the dumps will not be offensive to citizens, the cost of hauling is increased to a marked extent. Garbage dumps are unattractive and injure property valuations of adjacent areas.

Disposal by Sanitary Fill

By this is meant the depositing of garbage in excavations or on low ground that it is desired to reclaim. It is distinguished from dumping on land, in that the garbage thus dumped is mixed and covered with earth, ashes or other material, and in sufficient amount to prevent its causing a nuisance and yet not in sufficient quantities to prevent oxidation and disintegration.

The method has been used successfully by several cities, among them Seattle, Davenport, Ia., and New Orleans.

This method requires that garbage be combined with ashes and other refuse and thus makes possible the combined collection of all refuse. Where garbage is properly mixed with other material the method is free from nuisance. It is economical in undertaking as well as in operation. The initial cost may be nothing if private parties own the area to be filled since they are glad to have the value of their land thus increased. If the city purchases the land the initial cost will be the amount paid for the property, usually small because of the property being of little value. This payment is made up, however, many times over in the value of the land reclaimed. Davenport is improving its river front by this means. New Orleans is laying out the areas reclaimed for parks and playgrounds.

The cost of collection is less where this method is employed due to the possibility of the combined collection of garbage, ashes and rubbish. The cost was given by Davenport as 50 cents per ton. Seattle reported eleven fills cared for by eleven laborers, disposing of approximately 350 tons, "while one incinerator with about an equal pay-roll will only dispose of 60 to 75 tons per day, running 24 hours. A fill increased the value of property, while the refuse from one incinerator has to be hauled away at an added cost."

Burial.

By this method garbage is buried in trenches 5 ft. by 6 ft. or smaller. It is usually covered with the earth thrown up in digging the adjoining trench. Garbage thus disposed of will be taken up by the soil and usually in a period of three years will have become a part of the humus.

Burial of garbage is sanitary and should cause no nuisance where properly carried on. It was employed temporarily by Springfield, Mass., in 1916, but was objected to so strenuously on the part of property owners and residents that it was shortly discontinued.

For a large city such a method is unsatisfactory because of the large amount of land that is necessary, averaging from 1½ to 3 acres a year per daily ton, because of the long haul that is necessary to reach areas available for such disposal and because of the fact that no income can be derived from this method of disposal.

Plowing into Soil

This method is very similar to burial, the exception being that the garbage is covered with earth by means of the plow instead of being placed in trenches. As in the case of burial, garbage can be disposed of by this means in a sanitary manner, but with greater difficulty. However, the amount of land required, the usual long haul, and the lack of income do not make it desirable for a large city.

DRAINAGE AND IRRIGATION

The Unprecedentedly Good Outlook for Irrigation in 1918

By F. W. Park, 1625 Monadnock Block, Chicago, Ill.

(This article is an "eye-opener." To the man who thinks of irrigation only in connection with "the country God forgot," this article will be a revelation. All those interested in agricultural production, especially in regions contiguous to cities, should give this article a careful reading.—Editor.)

Both God and the Kaiser have contributed to the awakening that is certain to make this year the greatest in the irrigation growth of the country.

In the Great Plains where they produce a full crop only about one year in ten without irrigation the development of irrigation travels in cycles: The year following one of abundant rainfall, hope mounts high in the human breast and profits are spent in automobiles instead of irrigation pumping equipment. The year 1916 was a fruitful one in the Great Plains and every one of the faithful in Kansas advertised her bumper wheat crop. In 1917 things were different, with a drouth over large parts of Kansas, Oklahoma and in 105 counties of Texas. Thousands of farmers of small means in Texas have been compelled to sell their live stock and sacrifice their homes, and those with sufficient finances to hold on, have suddenly displayed keen interest in the Panhandle country, where in the area marked in our boyhood geographies "The Great American Desert," they are now producing enormous crops of alfalfa, grain sorghums and thorough-bred cattle and hogs through irrigation by pumping. Kansas also has recovered from her ecstacy and is now casting her weather eye in the direction of Garden City, where the United States Sugar & Land Co., are no longer trusting in Providence to supply the water, but are pumping from deep wells to irrigate tens of thousands of acres of sugar beets, kafir corn, milo, maize and alfalfa; the alfalfa yielding five cuttings to the acre each season, averaging 1¼ to 1½ tons to the cutting and converted into alfalfa meal and beef and pork all on their own ranches.

Great Field for Irrigation Close to Good Markets.

When the Kaiser shouted "Deutschland Uber Alles" and concluded that he could get away with it, the arid West was assured of high prices by the war and naturally developed her irrigation as the only means of increasing her agricultural production. But it's a difficult thing for the average American to conceive that agriculture under intensive methods in areas close to good markets offers far greater possibilities in the humid East than any place in the far West. Because crops cannot be produced in the arid regions without irrigation and some kind of a crop can be grown in most humid areas without artificial watering, the average man imagines that one who suggests irrigation in a region of large average rainfall must be a fit subject for a lunatic asylum. Besides, his grandfather produced crops without irrigation and then they have floods in which crops are actually drowned out, and why should one do anything different under these circumstances?

IRRIGATION PUMP HOUSE IN TEXAS. WELL 20 INS. IN DIAMETER, 140 FT. DEEP. EQUIPPED WITH AMERICAN 3-STAGE, 18 IN., DEEP WELL CENTRIFUGAL PUMP DELIVERING 1,000 G. P. M.

VIEW OF FRIZZELL'S PUMPING PLANT AT FORT LARNED RANCH, KANS.

The great irrigation development in the United States will be governed by convenience to good markets and will be in the semi-arid and humid regions and not in the limited arid areas capable of being irrigated in the far West. Irrigation will far more than double agricultural production in the Central and Eastern states, but its development must be accomplished through specialization first in favored areas and by the optical demonstration of the work of the large number of experts now located throughout the humid regions who are producing ten, twenty, and in many instances one hundred times as much by supplemental irrigation as the average farmer does without artificial watering. In a few years every farmer in a large part of the Great Plains will be educated to the fact that supplemental irrigation is his only reliable crop insurance and he must have his irrigation pumping plant. Garden truck grown under overhead spray irrigation produces so much greater in quantity and so much better in quality, that within a few years it will be impossible to dispose of the unirrigated product in the best markets. Already hundreds of great irrigated truck gardening enterprises are located close to Northern cities.

IRRIGATION PUMPING STATION AT PLAINVIEW, TEXAS. PUMP IS AMERICAN 24 IN., 2-STAGE, DEEP WELL CENTRIFUGAL BELTED TO OIL ENGINE, DELIVERING 1,500 G. P. M. AGAINST TOTAL HEAD OF 75 FT.

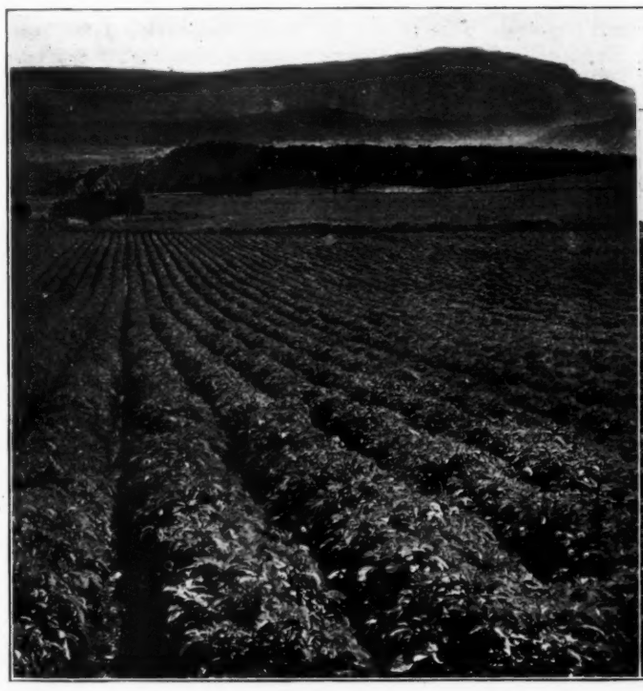
Irrigation in Regions of Great Rainfall.

Failure to recognize the importance of irrigation in areas of greatest rainfall is due to not understanding the following fundamental requirements: From 200 lbs. to 1,200 lbs. of water are required to produce every pound of solid matter in plant life, with a minimum of 400 lbs. for most plants. Plant growth stops immediately the ground becomes saturated by excess water, but also stops just as quickly when the roots no longer receive proper moisture. One inch of water is required for most garden truck in each ten day period during the growing season. Nearly all field crops require at least 1 in. of water every 20 days during the period of growth, and there are few crops that will produce a full harvest whenever less than 1 in. of rain falls within a 30 day period during the growing season. Study a rainfall chart of the United States and scarcely an area will be found even in regions of greatest average rainfall in which at least one 30 day period does not occur during the season in which less than 1 in. of rain falls, which should

indicate the absolute futility of obtaining maximum production in any locality without irrigation. The proof that this is not theoretical, but represents actual conditions, is demonstrated by what is now being accomplished in extensive widely separated areas and by hundreds of specialists in scientific agriculture throughout the Eastern and Central states.

Specific Examples of Profitable Irrigation in Humid Regions

Most of the costal plain of Texas has a comparatively large but uncertain rainfall. Truck gardening in this area without irrigation is not even a fair gambler's chance. Last year hundreds of farmers in this region produced from $600 to $800 per acre gross on every acre under irrigation.



POTATO CROP ON IRRIGATED LAND AT CARBONDALE, COLO., YIELDING AS HIGH AS 600 BUSHELS PER ACRE.

TYPICAL OVERHEAD IRRIGATION SYSTEM DESIGNED BY ENGINEERS, MUCH USED IN INTENSIVE AGRICULTURE NEAR LARGE CITIES.

Florida

Down at Bartow, Florida, J. R. Davis has been specializing in winter truck gardening for many years. He farms about 700 acres and notwithstanding that he is located in an area in which the average annual rainfall is about 60 in. his success lies in irrigation, and over 100 acres of his farm is equipped with an overhead spray irrigation system. For a half dozen years before the present high war prices his annual net profits exceeded $25,000.

Massachusetts

The Connecticut Valley Onion Co., South Deerfield, Mass., are the largest growers of onions in New England. Some of their farms are equipped with overhead irrigation while others are not provided with artificial watering. The average production of the irrigated farms is over 1,000 bushels of onions per acre, and the unirrigated farms less than one-fourth this quantity.

Michigan

At Three Rivers, Mich., where the average annual rainfall equals any other area in this latitude in the Eastern states, the R. M. Kellogg Co., have a 225 acre strawberry plantation, the largest in the world. Over 130 acres of this farm are under overhead irrigation, and the average annual gross production of the irrigated area is about $2,000 per acre.

New Jersey.

New Jersey receives about the average annual rainfall of most of the central Eastern states. Located at Bridgeton, N. J., is the Seabrook Farms Co., specialists in truck gardening. This company owns about 600 acres, part of which is under development, but have about 180 acres under overhead irrigation. For the year 1916, before the present high prices, the average gross sales of the entire acreage under irrigation was about $2,000 per acre, while certain acres produced over $3,450.

Arkansas.

Stuttgart, Ark., is the county seat of Arkansas county, one of the greatest rice growing areas in the United States. The rice must be kept flooded from the time it attains a growth of from 3 to 4 in. until about two weeks before harvest. Raw prairie land can be bought in this area at about $35 per acre. A well and pumping plant capable of irrigating 160 acres of this land will cost an average of about $6,000. Dozens of farmers around Stuttgart during 1917 produced over 100 bushels of rice to the acre on their entire acreage, which was sold to local dealers at from $2.03 to $2.14 per bushel, paying the entire cost of farm, pumping equipment, tools and labor expenses in a single year and netting them profits of 40 to 50 per cent on their investments besides. A conservative estimate of the

ONE OF TWO IRRIGATION PUMPING PLANTS IRRIGATING 240 ACRES NEAR LARNED, KANS.

value of the new irrigation pumping equipment that will go into this county during 1918 would be $1,000,000.

Colorado

High up in the mountains of Colorado, at Carbondale, Sweet Brothers, the potato kings, are located. They practice a four-year scientific crop rotation and irrigate. One year of the four is devoted to a wheat crop, producing an average of 65 bushels to the acre, weighing 62 lbs. to 64 lbs. to the bushel, but this is not considered a money crop. Another year oats are grown, producing 100 bushels on the average to the acre and weighing 42 to 45 lbs. to the bushel, but this also is not a money crop,—just a part of the rotation. The third year alfalfa is grown, yielding an average of five to six tons to the acre and this is considered a fair money earner. The fourth year in the rotation is the big money crop, produced by potatoes, of which about 125 acres are grown, averaging over 500 bushels to the acre, and of the finest quality, most uniform size, and commanding the highest market price of any in the world. Dr. Appell, the foremost potato authority of Germany, visiting this country before the war, declared he had never seen such potatoes and this, despite Germanys' boasted supremacy in potato raising.

Conclusion

To one who has watched closely the development of irrigation, the question arises: Had Germany been able to copy the methods of the leaders in irrigation of this country as closely as she imitated our inventions of warfare, would she not have been able to win the war? Similarly, if the entire farm population of the United States were persuing the methods of these same irrigation leaders, instead of the ridiculous improved farm average production of about $20 an acre, that we maintained before the war, we would be now growing enough food to feed the entire world.

FROM WORKERS IN FIELD AND OFFICE

Garbage Wagons in Use in Ottawa, Ontario

Editor of MUNICIPAL ENGINEERING:

Sir—A rear view of the garbage collection wagon in use in the city of Ottawa, Ontario, is here shown. It is of 6 cu. yds. level capacity, having a removable tail board and upper board on one side on hinges so that it may be dropped down for loading up to that level. The view shows the roll canvas cover on the upper left-hand side of the wagon box which

REAR VIEW GARBAGE COLLECTION WAGON USED BY OTTAWA, ONTARIO.

goes over the load when filled. The unloading device consists of five chains fastened to the rear end of the floor only and when in position for loading lies along the floor and up to the front to a hardwood cross piece to which they are joined in one ring. The cross chains are placed every 18 ins. and the canvas is fastened with clips to lie along the bottom on top of the chains. When the wagon is loaded and reaches the incinerator or dump the ring on the cross bar is attached to a cable and a team of horses on the dump or a motor at the incinerator rolls the load out over the back when this unloading device is then in the position shown in the accompanying view.

From this it will be seen that the load is all dumped behind the rear wheels and the unloading device is on top of the load just dumped so that it can be quickly placed back in position on the floor of the box and the back of the wagon replaced.

This unloading device which has been used also in Buffalo and Rochester for the unloading of refuse only is used here for the unloading of all material including ashes and garbage. I have not seen the canvas cover used in any other place but have found it useful, especially in the unloading of ashes. By this unloading device a type of wagon such as we have here can be used or even an ordinary box, which, however, should be strongly braced on the outside at it will be noticed we have done in these wagons, with ¾ in. iron braces. If this be not done there is a tendency for the box to drop while the load is being rolled out. The time required to unload will vary from one to three minutes, the shorter period being for favorable circumstances where the wagon can be backed up to the incinerator unloaded by a cable attached to a motor.

The horses required to pull these wagons, according to our local specifications, must weigh at least 1,500 lbs. as we have found this weight is necessary in the unloading of ashes in the winter time.

I adopted this type of wagon and this unloading device after I had investigated the different types of back dump and under dump wagons in the various cities in Canada and the Northern States. Most of these wagons I found were of relatively the same capacity, besides being too heavy for their capacity. The wagon box is made up of 1½ in. material with the exception of the bottom which is 2 in. material having 4 cross braces. The total weight of the wagon is 2,800 lbs.

Very truly yours,

ANDREW F. MACALLUM,
Commissioner of Works.

Ottawa, Ontario.

Unique Method of Building Reinforced Concrete Infiltration Gallery in Los Angeles River

The Editor of MUNICIPAL ENGINEERING:

Sir—

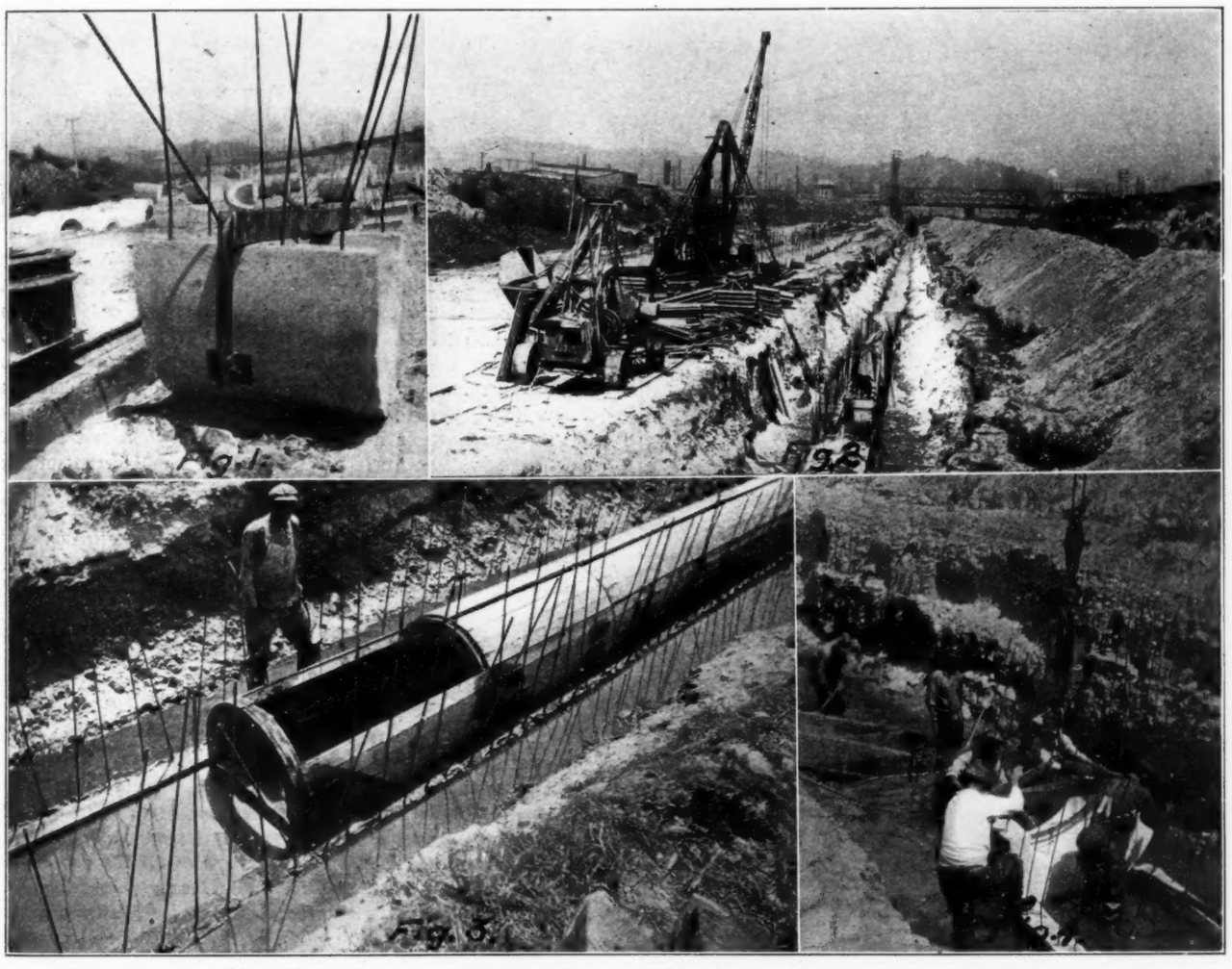
A novel method of transporting and lowering concrete pipe into a trench in the Los Angeles River is being used by the city of Los Angeles. The concrete pipe is built in sections of such a form and weight as to make it very difficult to handle them. A special set of tongs has been built, by an employe of the city, for this purpose. These tongs have two downward projecting arms that grasp the outer surface of the concrete section when the chain fastened to a crane pulls up on the tongs. The tongs are placed exactly in the center of the section.

After the section has been lowered into the trench the chain connected to the tongs is loosened and the tong is opened and locked in this position. It is then raised and fastened to another section.

The sections after being lowered into the trench are set by means of a frame mounted on four flanged wheels. This frame runs along the top of the sections that have been set and by means of two clips which fasten onto the steel rods extending from the top of the concrete sections the hoist supported by the frame raises and lowers the section until it is in the position desired. The frame is then moved up to the edge of the section just set, ready to repeat the operation on the next section when it is lowered.

These sections are to be used as a filtration gallery. This is an unusual method of building a gallery. The top section of this concrete gallery or tunnel will be built in one continuous section 8,000 ft. long.

The forms for building the top section are unique and of special design. The inside forms are supported by ribs which interlap each other at the top and are supported by a "V"-shaped chair, which in turn rests on the bottom of the concrete conduit. A stream of water is constantly running through the conduit, and the chair is so constructed as not to obstruct the water. An accompanying photograph shows how the ribs interlap at the top and also shows how they are supported by the chair. When the top section is hard, the chair is knocked out, which permits the ribs to fall out, making it easy to remove the inside forms. In the photograph the chair is supporting the ribs. The lower section of the gallery is running nearly level full of water. The steel rods are bent around the forms, reinforcing the top section and bonding it to the lower section.



VIEWS SHOWING CONSTRUCTION OF CONCRETE INFILTRATION GALLERY IN BED OF LOS ANGELES RIVER. FIG. 1—TONGS USED IN LOWERING SECTIONS OF INVERT. FIG. 2—GENERAL VIEW OF CONSTRUCTION OPERATIONS SHOWING STEAM SHOVELS IN DISTANCE, SECTIONS OF INVERT ALONG TRENCH, THE TRAVELING CRANE AND CONCRETE MIXER. FIG. 3—FORMS FOR ARCH SUPPORTED ON CHAIR RESTING ON COMPLETED INVERT. FIG.4—LOWERING SECTION OF INVERT INTO POSITION.

Very truly yours,

C. W. GEIGER.

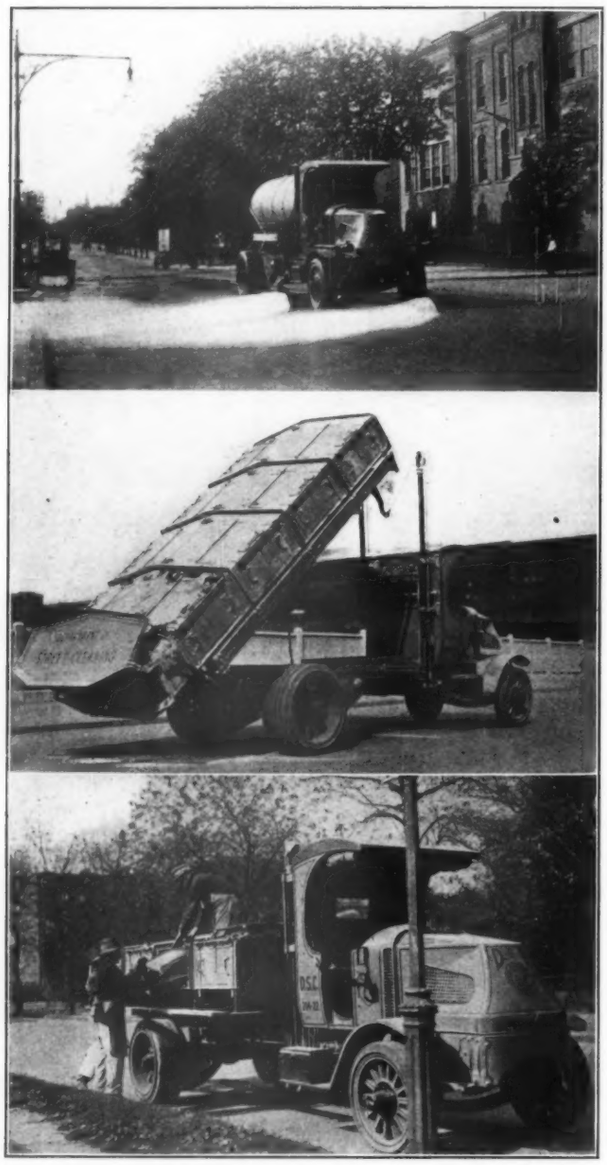
Los Angeles, Cal.

New Combination Flushing-Sprinkling-Refuse Collection Equipment of the New York Department of Street Cleaning

Editor of MUNICIPAL ENGINEERING:

Sir—The accompanying photographs show a combination street sprinkling or flushing machine and refuse collection vehicle, which consists of a 6½ ton Mack truck equipped for summer use as a flushing machine and for winter use as a refuse collection vehicle.

The flushing equipment includes a 1,500 gal. tank, a twin volute or two-stage centrifugal pump mounted in such a way



COMBINATION FULSHING - SPRINKLING - REFUSE COLLECTION MOTOR TRUCK OF TYPE OPERATED BY NEW YORK DEPARTMENT OF STREET CLEANING.

that it is driven directly from the main shaft of the truck. This pump supplies either two sprinkling nozzles or four flushing nozzles, with water at a pressure of approximately 40 lbs. All nozzles are under the control of the driver from the seat.

The machine will clean in excess of 100,000 sq. yds. of pavement in eight hours and requires but one man to operate it. The total weight, when filled with water, is approximately 28,000 lbs.

All parts of the flushing equipment are so constructed that they may be removed from the truck in the space of a few hours and replaced by a special power dumping body, at the end of the flushing season, or vice versa, at the beginning of the flushing season.

The refuse collection body is of a type known as Read body, provided with removable sides, to allow easy loading, and a covered top to reduce the dust nuisance. Its capacity is 10 cubic yds,, with provision for one cubic yard of water, so that it may be used on garbage collection and dripping of liquid from the load prevented.

The special advantage of this combination type is easy interchangeability from flushing to collection. This meets the peak load needs of northern cities by providing extra cleaning equipment in the summer, when it is most needed, and extra refuse collection equipment at a time when flushing cannot be performed, and when the production of ashes is so great that extra equipment must be made available.

Very truly yours,
J. T. FETHERSTON, Commissioner,
New York, N. Y. Department of Street Cleaning.

Motor Truck Service is All-Important

To the Editor MUNICIPAL ENGINEERING:

Sir—With reference to the operation and cost of auto trucks used by the Bureau of Highways of the Borough of Queens of the City of New York, we did keep cost when we first purchased these trucks, but found from experience that keeping cost on this particular equipment only afforded us general information for the reason that there was a continual fluctuation. The cost information would only be necessary for the purchase of new equipment, and we found that the most important point, from our point of view, is that of service, regardless of the truck's value itself.

Very truly yours,
C. H. SHEPHEARD,
Long Island City, N. Y. Assistant Engineer.

Flying Squadron of Laborers on Pennsylvania Highway Work

Editor MUNICIPAL ENGINEERING:

Sir—Our experience with flying squadrons of laborers is very limited, but we are satisfied that the same can be worked successfully. We have just purchased nine five-ton trucks and are having them equipped with snow plows and are going to send these out with a few laborers in an attempt to keep the main highways open during the winter, particularly the Lincoln Highway, which is now used to take all the new trucks and pleasure cars east. We have also leased quarries and installed crushers throughout the State and are going to get out stone for this year and are going to try having squadrons move from place to place in the trucks and live in tents, particularly on maintenance work, as I feel it would be a great mistake to allow our roads already built to deteriorate. We are also laying out a plan for new roads whereby local material can be secured, which will eventually work into a system and we expect to do considerable work this year providing we can get prices which will justify the work.

Very truly yours,
J. D. O'NEIL,
Harrisburg, Pa. State Highway Commissioner.

Good Record Made With Elevating Grader on Irrigation Reservoir Construction

Editor of MUNICIPAL ENGINEERING:

Sir—The accompanying view shows a section of dam I built on contract and on which I made a record with a Western Elevating Grader and Western dump wagons which has caused

considerable comment. In the month of August, 1917, we put in 19,129 cu. yds. of fill in 26 days. My foreman, W. R. Burck, is an artist at dirt moving and by keeping the 15 wagons constantly "turning," and because of little trouble we had, we made the creditable record mentioned.

VIEW OF GRADING OUTFIT ON LEAN SPRINGS IRRIGATION RESERVOIR CONSTRUCTION IN TEXAS.

The job on which this record was made is the Lean Springs reservoir for irrigation purposes. The work comprises the placing of 90,000 cu. yds. of fill and 15,000 sq. yds. of riprap. The reservoir will hold about 7,000 acre-feet of water and is fed by the largest spring in the Southwest.

The elevating grader used is new, and outside of belt trouble we did not have any delays. Constantly keeping watch for trouble that might arise, keeping all wagons constantly on the move and plenty of oil on the bearings will do much to make big estimates for contractors on work like this.

We used 3 up wagons, chiefly, on about a 1,000 ft. average haul and loaded the wagons to their full capacity.

The record run mentioned was made on the lower lifts of the dam in which we put in 4 ft. lifts and bordered up and irrigated. A feature we find to work well is to put on a lift and put 4 in. of gravel on the front slope which is 3 to 1. We can thus carry up the riprap as the work progresses and in this way finish all parts of the work at about the same time.

Very truly yours,

Ft. Stockton, Texas. W. E. HAMILTON, Contractor.

DIGEST OF THE ESSENTIAL NEWS

New Jersey Plans to Spend $5,000,000 on Highways This Year

Major General George M. Goethals, supervising engineer of the New Jersey State Highway System, on which $15,000,000 is to be spent, has filed a report with the State Highway Commission which has been embodied in a communication to Governor Edge. The proposed system, based upon a direct State tax, has withstood legal and political attacks upon it and may now be considered a sure thing.

The commission shows that the tax will make available $3,165,000 for the first year's work, in addition to which there will be about $2,000,000 from the Motor Vehicle Department for repair work in the various counties.

General Goethals recites the work done in mapping out the fifteen routes and their alternatives and the various estimates and office work done. Scarcity of engineers for the surveys has retarded the work. This shortage is due to the war. Despite this handicap the entire system will be mapped and its costs estimated in detail—this work is about completed.

No work will be done until about April 1, 1918, or as soon as the winter breaks up. However, construction work has been started on roads leading to Camp Dix at Wrightstown and to Camp Merritt at Tenafly. At Camp Dix a four mile stretch was built with labor from the Rahway Reformatory, and this cost $90,000.

Cleveland Will Spend $5,000,000 for Comprehensive Sewer Construction

A vote was taken in Cleveland on November 6, 1917, in connection with authority to issue $3,000,000 worth of bonds for sewer purposes, and passed by the necessary two-thirds majority. Relative to the expenditure of these funds Robert Hoffman, commissioner and chief engineer of the Department of Public Service, writes as follows :

This amount of money is to be used in paying the city's portion of the cost of sewer construction which is expected to take place during the next four or five years. The property owners' contribution towards the expense of paying for the sewer construction is in addition to the $3,000,000 bond issue, so that the total amount of work will probably amount to at least $5,000,000 in connection with this program.

The list of work, and the amount of the same which may be placed under contract this coming season, has not yet been definitely determined. Considerable engineering work is still required in the design and planning of main sewers.

The program for the year 1918 will quite likely be decided by January 15. It has been found desirable in this city to start on a fairly large, comprehensive plan of sewer construction, for the reason that a number of the old sewers, built forty or fifty years ago, will require reconstruction because they are becoming physically unfit or they are proving inadequate in size and depth to accommodate districts which they serve. The rapid growth of the city is also demanding large expenditures for sewers in order to provide adequate sewer facilities in the newer portions of the city.

It has seemed impractical to make any proper progress in connection with sewer work under the method which has formerly existed, in supplying only a limited amount of funds each year for sewer construction, as such sum has not in recent years proved adequate properly to provide for the projected necessary work.

With the sum available under authority of the new proposed bond issue, the department will be able to lay out a comprehensive, practical program extending over several years, since the assurance is had that the financing of the work will be possible as soon as plans are prepared.

Illinois State Highway Plans Gain Great Momentum

Illinois' drive for the five federal highways was probably the greatest ever made in a like period in the history of any state. It presages, those in direct charge of the movement believe, an overwhelming victory for the Illinois $60,000,000 road system to be voted on this year.

As a direct result of the work done throughout the state, public interest has increased in favor of the five fed-

eral highways now pending in Illinois. Clark, Effingham and Bond counties, located along the national old trail road, have voted county bond issues to secure their share of the federal and state aid to build this old, historic highway. Menard, Mason and Sangamon have voted county bond issues to build the Peoria-Springfield and the Springfield and St. Louis roads. Just recently Macoupin county, by a vote of 2,200 majority, decided to issue bonds to build their share of the road from Springfield to St. Louis.

On Oct. 23, Lake County voted $500,000 and on Nov. 6, Cook County authorized a $1,000,000 county bond issue to complete Sheridan road to the Wisconsin state line, and a secondary road to give relief to the traffic between Chicago and the Great Lakes Naval Training Station, as well as Fort Sheridan.

Winnebago County has voted bonds in favor of improving Grant highway from the City of Rockford to the east county line, and it is expected that Boone County will vote on a $400,000 bond issue this winter to improve this highway through Boone County. Of the twelve counties located along the five federal highways, who were required to vote county bond issues, only one voting so far, has lost, and that was in Fayette where the issue was defeated by less than 200.

It is understood they are already planning to resubmit the matter to the voters of that county. Cumberland and Madison counties are the only other counties remaining to vote, and it is expected that the bond issue will be authorized by the people of these enterprising communities.

Review of Bids Submitted on California State Highway Construction

A review of the bids submitted on California State highway construction in 1917 shows that, omitting one contract calling for re-surfacing only, 133 bids were received from 55 different contracting firms on 36 different pieces of work, says Western Engineering. On one contract bids were received twice, and rejected both times. The largest number of bidders on any one contract was nine, for grading the highway in Santa Barbara county between Las Cruces and Gaviota pass. On several contracts only one bid was received. In all, 32 contracts, covering 261.36 miles of highway, were awarded. Eight of these contracts, covering 73.7 miles of highway, were for grading, culverts, and similar work, and did not include paving; 4 contracts, covering 26.5 miles of highway, were for "finishing-grading" and paving, where the rough grading had been done before, while 20 contracts, covering 159.16 miles of highway, included both grading and paving. The total contract price was $2,302,740.23. The cost of materials furnished by the state will be approximately $1,250,000, making a total of over $3,500,000. To this amount should be added the cost of asphaltic surfacing for the concrete pavement, the State Highway Commission's overhead, and the cost of right-of-way and some large bridges. The total cost of this work will probably be between $4,000,000 and $4,500,000.

Bids Compared with Engineers' Estimates of Cost

A comparison between the engineer's estimate and the bids is of interest. For the first eight contracts, which were awarded in May, the figure named by the lowest bidder was in each case below the engineers' estimate and 15 were for more than the estimate. For the entire season, the sum of the bidding prices is $21,868.60 more than the engineers' estimate. This does not include jobs on which all bids were rejected.

Excavation

Classification of excavation to have been practically abandoned by the State Highway Commission engineers. On only one contract does any other grading item than excavation without classification appear. In this case there is an item of borrow excavation, presumably hauled for a considerable distance, taking the price named by the low bidder, $0.80 per cubic yard, as a criterion. Excavation without classification is an item of all of the 32 contracts awarded. The lowest price was $0.39, the highest $1.05, and the average $0.704 per cubic yard.

Concrete

Concrete in culverts and monuments, the State furnishing all materials, is an item in 21 contracts. There is a wide range in prices, the lowest being $6, the highest $22, and the average $12.34 per cu. yd. On 8 contracts, the State furnished only the cement. The lowest price is $12, the highest $17.50, and the average $14.94 per cubic yard.

Concrete in pavement, the State furnishing all materials, is an item in 22 contracts. The lowest price is $3.09, the highest $6, and the average $4.19 per cu. yd. On 3 contracts the State furnished only the cement. The average price is $6.43 per cubic yard.

Miscellaneous Bidding Prices

Other bidding prices are as follows: Concrete in retaining walls, the State furnishing only the cement, is an item in 3 contracts. The average price is $13.33 per cu. yd. Dry-rubble masonry retaining-walls are an item in 4 contracts. The average price is $6 per cu. yd. Ordinary rubble-masonry is an item in 1 contract at $7 per cu. yd. Guard-rail figured at from $0.40 to $0.50 per foot. Laying corrugated metal pipe is an able that average figures would mean little or nothing.
item in most of the contracts, but the prices quoted are so vari-

Trend of Prices for 2½ Years

A study has been made of the trend of bidding prices on this work for the past 2½ years. Figures have been compiled covering low bids on contracts awarded between Dec. 14, 1914 and July 26, 1915.

Excavation without classification was an item in 26 contracts, the lowest price being $0.30, the highest $0.70, and the average $0.50 per cu. yd. Concrete in culverts and monuments, the State furnishing all materials, was an item in 19 contracts. The lowest price was $6, the highest $15, and the average $10.10 per cu. yd. On 9 contracts, where the State furnished only cement, the lowest price was $7.50, the highest $16, and the average $11.05 per cu. yd. Concrete in pavement, the State furnishing all materials, was an item in 15 contracts. The lowest price was $2.20, the highest $4.25, and the average $2.90 per cu. yd. On 5 contracts, where the State furnished only cement, the lowest price was $3.49, the highest $6.15, and the average $4.41 per cubic yard.

In view of the above facts, it may safely be stated that the labor-cost of highway construction has increased at least 40% during the past two and one-half years. Fortunately for the general public, the increase in the cost of materials, while it has been large, has not been so large as the increase in the cost of labor.

Motor Freight Highways Will Aid in Solution of Transportation Problem

In congested localities private freight shipments are being seriously held up to the detriment of practically every line of manufacturing and general business. The situation is so serious that railroads in nearly every section of the country are begging for relief by outside means of transportation, and in one case the officials of one of our great systems of railroads have even made the suggestion that all passenger service, with the exception of parts of the roads which exclusively serve isolated sections, be annulled, thereby doing away with and turning over to competitive lines all through passenger business between Boston, New York, Philadelphia, Baltimore and Washington and all western points on that company's system. The object is to convert the entire trackage to the carrying of freight, says S. M. Williams of Lima, Ohio.

Motor Freight Highways Offer a Solution.

One of two solutions towards assisting the railroads in handling the enormous amount of freight follows:

The utilization of the highways of the United States for the delivery of freight to and from congested terminal cities. Our highway systems, as they are already laid out, are elaborate, and reach every section of the country outside our large cities, and roads from every direction are running into these cities. Many of these roads have been improved, but they have not been built for the unusual strain that will be placed on them if large numbers of heavy motor trucks are started out over them on regular routes and runs such as would be necessary in handling intercity freight business. Heavier foundations and higher types of roads than those generally constructed in the past will be absolutely necessary if our roads are to be used for the transportation of large quantities of freight.

Motor Truck Traffic Has Increased at Enormous Rate.

Already motor truck traffic in the vicinity of our principal cities has increased at such an enormous rate, even within the last six months, that our highway officials and those officials in charge of the maintenance of such suburban roads have become much alarmed owing to the great damage that has been and is being done by the increase in traffic and the increase in the loads that are being hauled over the roads.

No one can readily be blamed for this condition, as it was impossible to foresee, only a few years ago, when the roads were built, what a sudden increase there would be. It is generally admitted now, however, that in the vicinity of our larger cities, and on routes between large cities, where the advantages for installing intercity motor-truck freight lines are considered favorable for the operation of such lines, only the highest types of roads must be constructed.

Present Regular Lines of Freight-Carrying Motor Trucks

Many regular lines of freight-carrying motor trucks are now operating from Boston, Hartford, New York, Albany, Trenton, Philadelphia, Atlantic City, Baltimore, Wilmington, Del., Washington, Cleveland, Detroit, Chicago, Pittsburgh, Los Angeles, San Francisco, Portland, Seattle and other cities. The longest line operating on a regular schedule at the present time is one between Akron, Ohio, and Boston, Mass., trucks starting from both terminals daily. This line operates seven days a week and each truck makes the round trip of about 1,500 miles in less than a week.

Successful lines are also operating between Chicago and Gary, Ind., twenty-five miles; Chicago to Elkhart, Ind., 110 miles; Chicago to Rockford, Ill., 95 miles, and between Boston, New York, Philadelphia and scores of manufacturing cities within a radius of 50 miles and more.

On the western coast, in the State of California, where, owing to improved roads, we find 42 responsible companies operating fleets of trucks between 60 separate and distinct terminals, and this does not include the intermediate points to which service is rendered through the highway transportation.

Pavements of Most Durable Types are Requisite.

The motor truck freight lines, as well as scores of others in different parts of the country, have thoroughly demonstrated the importance of highway transportation, and that when operated upon properly constructed roads the service is both economical and dependable.

The actual running of these lines has proven beyond all doubt, however, that more attention must be paid to the improvement of roads over which such lines may be expected to run in the future, and that only pavements of the highest and most durable known type should be laid by the officials in charge of the construction of our highways.

The traffic for highway transfer is here and you cannot curtail it. Regardless as to whether we are at war or peace it will continue to grow, and it must be met in an intelligent and sane manner. The building of temporary or cheaply constructed roads insures, in a comparatively short time, that the maintenance and repair charges plus the original cost of construction will more than equal the cost of the higher and more dependable type of pavement.

Baltimore's Street Paving Program for 1918

The Paving Commission of the City of Baltimore has just issued the following lists of streets and alleys selected for improvement in 1918. These lists are tentative. Changes may be made either in the limits of the streets or alleys or the order in which they may be improved. Of course the Commission may add such streets and alleys not mentioned in these lists as may be decided on during the year 1918.

Streets Definitely Selected for Improvement.

Exter St., from Pratt St. to Fleet St. Gough St., from Central Ave. to Lloyd St. Lloyd St., from Gough St. to Granby St. Stiles St., from Central Ave. to East Falls Ave. Charles St., from Read St. to Chase St. Lexington St., from Guilford Ave. to Calvert St. Centre St., from Fallsway to Courtland St. Orleans St., from E. b/l Forest St. to W. b/l Broadway. Caroline St., from N. b/l Pratt St. to S. b/l Monument St. Lanvale St., from E. b/l Fulton Ave. to W. b/l Carrollton Ave. Lanvale St., from E. b/l Arlington Ave. to W. b/l Druid Hill Ave. Franklin from Park Ave. to E. b/l Howard St. Raborg St., from Stockton St. to Greene St. McElderry St., from E. b/l Patterson Park Ave. to E. b/l Luzerne Ave. McElderry St., from E. b/l Wolfe St. to W. b/l Chester St. Jackson St., from E. b/l Aisquith St. to W. b/l Central Ave. St. Matthews St., from E. b/l Central Ave. to S. b/l Lexington St. Sanders St., from W. b/l Covington St. to E. b/l Riverside Ave. Covington St., from N. b/l Gittings St. to S. of Sanders St. Russell St., from Stockholm St. to Fremont Ave.

Alleys Definitely Selected for Improvement.

Jordan Alley, from S. b/l North Ave. to N. of Wilson St. Jordan Alley, from S. b/l Wilson St. to N. b/l Mosher St. Jordan Alley, from S. b/l Lafayette Ave. to N. b/l Biddle St. Tiffany Alley, from N. b/l Orchard St. to S. b/l Lanvale St. Tiffany Alley, from N. b/l Lafayette Ave. to S. b/l Bloom St. Shields Alley, from N. b/l Greenwillow St. to S. b/l Pitcher St. Mason Alley, from S. b/l Dolphin St. to N. b/l Hoffman St. Mason Alley, from S. b/l Preston St. to N. b/l Camel Alley. Camel Alley, from E. b/l Madison Ave. to W. b/l Cathedral St. Jenkins Alley, from N. b/l Hoffman St. to S. b/l Dolphin St. Lovegrove Alley, from S. b/l Franklin St. to N. b/l Elizabeth Ct. Lovegrove Alley, from N. b/l Mt. Royal Ave. to Jones Falls. Lovegrove Alley, from N. b/l Lanvale St. to N. b/l Trenton St. Rice St., from E. b/l Carrollton Ave. to W. b/l Fremont St. Rice St., from W. b/l Carey St. to E. b/l Woodyear St. Woodyear St., from S. b/l Lanvale St. to N. b/l Franklin St. Vincent Alley, from N. b/l Hollins St. to S. b/l Saratoga St. Vincent Alley, from S. b/l Pratt St. to B. & O. Right of Way. Booth St., from W. b/l Carey St. to E. b/l Vincent Alley. Brexton Alley, from S. b/l Eager St. to W. b/l Cathedral St.

Tentative List of Alleys for Improvement in 1918.

Cider Alley, from Paca St. to Greene St. Durst St., from Fort Ave. to Cross St. Mt. Clare Alley, from Lanvale St. to Lafayette Ave. Stump Alley, from Conway St. to Barre St. Bruce St., from Edmondson Ave. to Harlem Ave. Iron Alley, from Baltimore St. to Lombard St. Pin Alley, from Arch St. to Pine St. Boyd Alley (St.), from Parkin St. to Fremont Ave. Stoddard Alley, from Mosher St. to McMechen St. Alley rear 1369 Carey St., from Presstman St. to Laurens St. Pierce St., from Pearl St. to Pine St. Alley N. of and parallel with Jefferson St., from Eden St. to Central Ave.

Tentative List of Streets for Improvement in 1918.

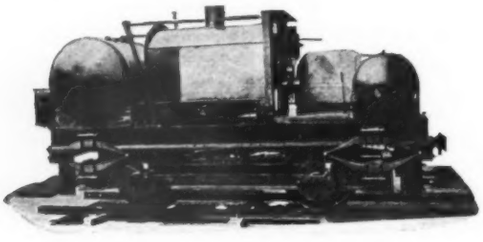
Bank St., from Ellwood Ave. to East Ave. Spring St., from

Biddle St. to Hoffman St. Brentwood Ave., from Biddle St. to Eager St. Barclay St., from Chase St. to Biddle St. Forrest St., from Monument St. to Eager St. Forrest St., from Chase St. to Biddle St. Collington Ave., from Hoffman St. to Federal St. Bethel St., from Pratt St. to Madison St. Mott St., from Gay St. to Ensor St. Stirling St., from Mott St. to Aisquith St. Mullikin St., from Ann St. to Aisquith St. Linwood Ave., from Madison St. to Federal St. Lancaster St., from President St. to Caroline St. Aliceanna St., from East Falls Ave. to Caroline St. Fleet St., from East Falls Ave. to Central Ave. Brevard St., from Wilson St. to North Ave. Somerset St., from Madison St. to Biddle St. York St., from Light St. to Battery St. Henry St., from Key Highway to Water Front. Fayette St., from Poppleton St. to Smallwood St. Lombard St., from Fremont Ave. to Payson St. Federal St., from Broadway to Eastern City Line. Montford Ave., from Pennsylvania Railroad to Lafayette Ave. Montford Ave., from Eager Place to McElderry St. Luzerne St., from Baltimore St. to Madison St. Preston St., from Gay St. to Eastern City Line. Lanvale St., from Fulton Ave. to Payson St. German St., from Eutaw St. to Howard St. Lombard St., from Hanover St. to South St. Payson St., from Lanvale St. to Mosher St. Collington Ave., from Biddle St. to Ashland Ave. Collington Ave., from Pratt St. to Fleet St. Chester St., from Pratt St. to Fleet St. Pratt St., from Broadway to Patterson Park Ave. Graves St., from Monument St. to Madison St. Luzerne St., from Eager St. to Federal St. Biddle St., from Montford Ave to Loney's Lane. Chase St., from Milton Ave to Luzerne St. Milton Ave., from McElderry St. to North Ave. Ellwood Ave., from O'Donnel St. to Eastern Ave. Bolton St., from Preston St. to Biddle St. Lakewood Ave., from Fait Ave. to Boston St. McDonogh St., from Madison St. to Ashland Ave. Poultney St., from Patapsco St. to Light St. Ostend St., from Light St. to Williams St. Grindell St., from William St. to Riverside Ave. Clement St., from Jackson St. to Key Highway. Arlington Ave., from Baltimore St. to Pratt St. Jefferson St., from Milton Ave. to Lakewood Ave. Orleans St., from Milton Ave. to Lakewood Ave. Ashland Ave., from Patterson Park Ave. to Milton Ave. Bond St., from Baltimore St. to Madison St. Hill St., from Charles St. to Light St. Warner St., from Carey St. to Bayard St. Russell St., from Stockholm St. to Bush St. Winder St., from Light St. to Hanover St. Albemarle St., from Eastern Ave. to Fleet St. Albemarle St., from Baltimore St. to Pratt St. William St., from Clement St. to Fort Ave. Clement St., from Light St. to William St. Lakewood Ave., from Fayette St. to Baltimore St. Olive St., from Hopewell St. to Clement St. Lemmon St., from Eutaw St. to Paca St. Clinton St., from George St. to Myrtle Ave. Edmondson Ave., from Clinton St. to Fremont Ave. Federal St., from Broadway to Gay St. Smallwood St., from Lexington St. to Franklin St. Ashland Ave., from Aisquith St. to McKim St. Greenmont Ave., from North Ave. to Hiller St. North Ave., from Port St. to E. b/l Minebank Lane. Lexington St., from Center Ave. to Caroline St. Washington St., from Fayette St. to North Ave. Columbia Ave., from Greene St. to Fremont Ave.

Plant Units and Lay Outs

An Oil-burning Steam Locomotive

The oil-burning steam locomotive here illustrated is thoroughly tested under operating conditions and has proved its worth. The Bell unit engine has only 15 moving parts and is geared direct to the axle. It runs in oil and is of first-class construction throughout. The manufacturers claim that it is the most highly developed steam engine made. The engine unit can be removed and replaced in two hours time and requires practically no attention. The horizontal tubular boiler is wire bound and has steel tubes welded into the fire box head and is free of seams and rivets. It is quick firing and



VIEW OF OIL BURNING STEAM LOCOMOTIVE.

gives high-pressure superheated steam. It is easily cleaned. Water is carried in a riveted steel tank, placed just ahead of the boiler, while the liquid fuel is carried in a cylindrical tank located in the engine cab. Water is fed to the boiler from the tank by an injector. Side rods take the drive from the front to the rear wheels.

Locomotives weighing from 2 to 10-tons are equipped with hand operated brakes, while locomotives weighing more than 10 tons are equipped with steam or air brakes, as the buyer specifies. The manufacturers can furnish burners for gasoline, kerosene, fuel oil, or any kind of liquid fuel. Its design lends itself readily to the production of locomotives that are narrow, low and short. With the use of liquid fuel there are no sparks, hot ashes or smoke. A licensed engineer is not usually required to operate one of these locomotives, even in such localities as New York City. Any handy-man of average ability can operate and care for a Bell locomotive after a few days' practice. These locomotives are suitable for contractor's use especially.

The center of gravity is as low as possible, and this, in connection with the flexible frame, permits of high speed on rough tracks. Starting when cold, the locomotive can be fired up and ready for operation in from 15 to 20 minutes. Sizes range from 2 to 18 tons. These locomotives are manufactured by the Bell Locomotive Works, 30 Church Street, New York City.

An Adjustable Manhole Top

Constantly increasing volume of traffic and extremely heavy trucks with heavy loads has presented a problem of street paving construction which is becoming more and more difficult to solve. In many cities they are endeavoring to eliminate entirely or at least minimize the placing of manhole covers in the street because of the constant subjection to claim for damage on account of the broken covers and consequent law suits. Thus we have two city departments working antagonistically to each other: the Claim Department fighting for the elimination of covers and the Water Works and Sewer Department endeavoring to keep open reasonable means of access to their underground lines. Many patterns of specially con-

structed manhole tops have been patented and put on the market with view to overcoming difficulties. Among these is the S. E. T. Adjustable Manhole Top. It is very practical and efficient and accomplishes the purpose desired.

This top consists of a frame in two parts, the upper part riding on the lower part with corrugated cover resting in the upper part. The lower half has a flange which rests on concrete or brick manhole. Inside it is fitted with a triple set of inclined planes, the upper half having corresponding planes so that when the upper half is put in position, we have one set of planes riding on the other, the whole constituting an adjustable feature with sufficient range to meet ordinary re-adjustment requirements of wearing away of the pavement or slight grade changes.

This manhole top prevents the rattling or dishing out of the cover, first: by the deep flange on the underside of the cover which extends down below the frame lid, and second, by the 4 in. width of the rim of the frame in which the cover rests.

S. E. T. ADJUSTABLE MANHOLE TOP.

The effect of this wide rim is to prevent the cover from disturbance by sudden shocks from heavy and swift traffic because the rim takes the impact. In other words, in the ordinary manhole cover frame the width of rim is only 1 to 1½ in. This rim, especially when projecting at all above the surface of the street, makes an obstruction to the wheel, sending it up into the air and letting it come down square on to the corrugated cover. With the wide rim of the Adjustable Top, the wheel has 4 ins. of surface to run over before reaching the cover. The consequence is, the cover wears uniformly with the rim and always stays in place. The adjustable feature keeps the roadway smooth because of the comparative ease with which it is kept level with the roadway.

A 2-Ton Motor Truck Popular with Contractors

The 2-ton Master truck is proving popular with contractors. Whitlatch Bros., of Beacon, Iowa (general contractors of concrete and structural steel bridge work), report much satisfaction with their Master truck and state they have made many trips heavily loaded, covering a distance of 68 miles through spongy country roads. Conrad Schuck, dealer in coal, stone and builders' supplies, 309 Quay St., Pittsburg, Pa., operated one of these trucks for a period of three months under severe condiitons, in nearly every instance hauling over-loads, the loads ranging from 2½ to 3¼ tons. These loads were transported over the hilliest district in Pittsburg, over streets rough for the greater part and unimproved. The Schackleford Brick Co., of Des Moines, Ia., find that their Master does the work that would be a credit to a larger truck and does it on the cost basis of a 2-ton truck. They have operated their truck every day for nearly a year without a cent for repairs.

A Handy Tractor Truck

A tractor truck of much utility is here illustrated. It is of Merchant & Evans Co. manufacture. The truck has a 9-ft. wheel base and a 6x12 ft. body. A longer body can be used. The truck turns completely around in a circle of 9 foot radius. Either steel or rubber tire rear wheels can be used. The truck

THE M. & E. HANDY TRACTOR TRUCK.

has 5-ton capacity and has had almost a year's successful operation. It is estimated that the cost of operating the truck is $8.33 per day, for 300 working days in the year, with an average daily travel of 25 miles. This cost is distributed as follows:

Front tires	$110
Oil and grease	50
Gasoline	310
Garage	180
Driver	720
Insurance	50
	$1420

In addition to this 6% interest on the investment amounts to	$180
20% depreciation	600
Maintenance	300
Making a total overhead charge (annual) of	$1080
Which added to the other expense makes a total, per year of	$2500.00

These trucks are especially appropriate for the use of contractors because of their extreme flexibility of operation.

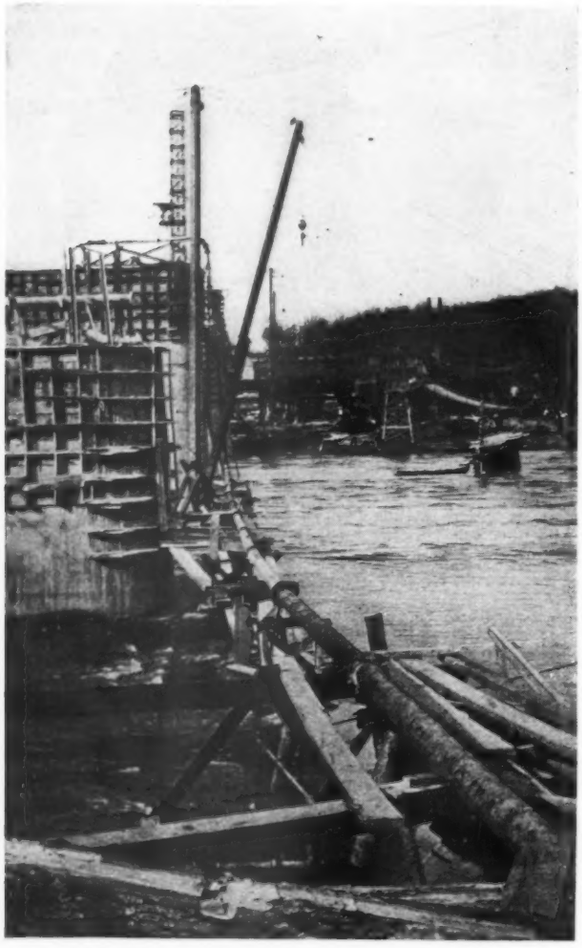
The New Pneumatic Process of Mixing and Placing Concrete

The New Pneumatic process of mixing and placing concrete is both effective and economical. The concrete is mixed in batches and transported to its final place by means of compressed air acting through pipe lines. The mixing equipment, here illustrated, consists of three hoppers. The first two hoppers are for measuring and mixing the concrete; the third hopper forms part of an air sealed chamber. The material is fed to the upper hopper in its proper proportions of sand, stone, cement and water. This batch then passes through to the second hopper and the first hopper is again ready for an-

other batch. This action imparts the proper motion of rotation to the concrete materials and produces a mix exactly similar to that secured in the familiar batch mixer, except that the contents are rotated instead of the mixer itself. This method of mixing concrete has been in successful operation for years.

After leaving the second hopper the batch enters the third hopper and an air operated door closes this chamber and air is immediately applied to the concrete which in a thoroughly mixed state is conveyed through the discharge pipe to its place in the forms.

The conveying line used is an ordinary 6 in. wrought iron or steel pipe. Any degree of curvature can be introduced into the discharge line without danger of stoppage. The discharge line terminates in a specially constructed nozzle which permits the concrete to be deposited wherever required.

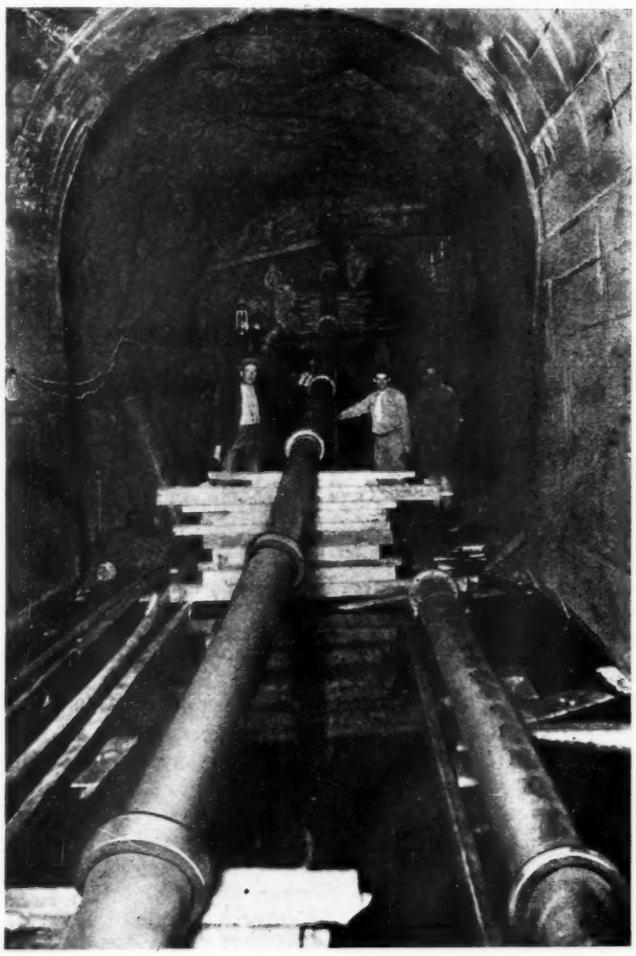


PNEUMATIC INSTALLATION FOR BRIDGE PIER.

The compressor capacity depends entirely on the quantity of concrete required per unit of time and the distance it is to be conveyed. The maximum distance of conveyance by this method thus far attained is 4,000 ft., but except under extraordinarily favorable conditions, it would be uneconomical to convey concrete to such a great distance. Oftentimes it is possible to install two unit compressors, operating one at short distances and the two on the longer distances.

Especially great are the advantages of this method of mixing and placing concrete on work where concrete is to be deposited at considerable distances from the mixer, whether this distance be horizontal or vertical. Where the forms are difficult of access, this method is also especially appropriate as by it the concrete can be deposited wherever it is possible to lay a pipe line. This method is in operation in this country on all kinds of concrete work, both on heavy mass construction and on thin impervious construction. It is acknowledged to be the most economical method of concreting tunnel lining, sewers, etc.

The accompanying views illustrate two successful applications of this method. One view shows a Pneumatic installation for tunnel lining. In tunnel lining by this method, the pipe is usually led along the side of the tunnel out of the way of the miners and other workmen, thus allowing the concreting to continue without interrupting the driving of the tunnel and removing the spoil. The pipe enters the form as illustrated and the concrete is conveyed through it to its final place. Few men are required at the form. The old method in work of this sort is to run the concrete car up an incline, dump on a platform and then a gang of 15 or more men are required to shovel the concrete into place. This is a slow process, especially as the work approaches the key of the arch.

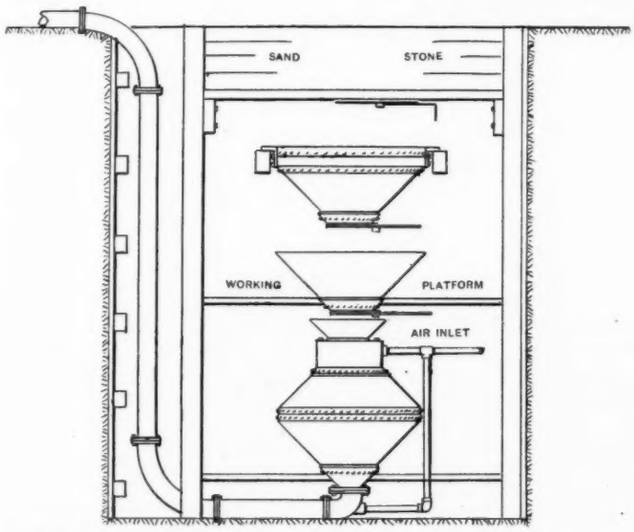


PNEUMATIC INSTALLATION FOR TUNNEL LINING.

With the Pneumatic method only two or three men are required to watch the forms, bulkhead and pipe. The key of the arch is concreted as quickly as the side wall at the rate of 18 to 25 cu. yds. per hour.

The remaining illustration shows a Penumatic installation used in concreting a bridge pier. On this work the machine was set at about 100 ft. from the pier and the conveying pipe line laid to the base of the pier, with an elbow in the line looking up. As the pier advanced in heighth the pipe line was extended to enable concrete to be placed in the next section of forms. This process was continued until the top of the pier

was reached, a total heighth of 125 ft. On this particular job the Pneumatic method saved the contractor the large and expensive concreting tower. It did not require surplus lumber or a large number of carpenters and reduced the concreting



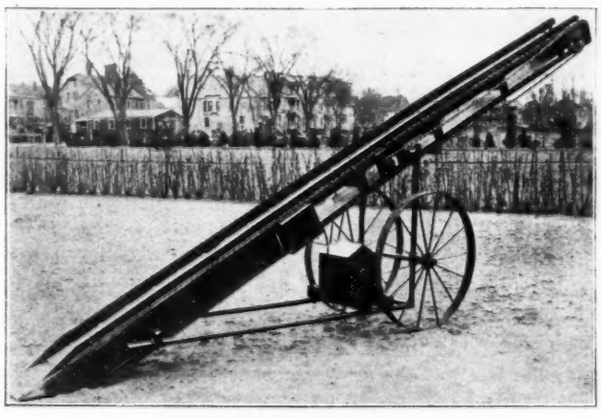
RELATION OF PARTS IN MIXING EQUIPMENT USED IN NEW PNEUMATIC PROCESS OF MIXING AND PLACING CONCRETE.

gang from the 20 or 25 men that would have been required by the old method to 5 or 6 men by the Pneumatic method. In addition the Pneumatic method speeded up the job and enabled the contractor to complete the work before contract time.

The machinery ilustrated and described is manufactured by the Pneumatic Concrete Machinery Co., 2 Rector Street, New York City.

A Portable Scoop Conveyor

A new type of portable belt scoop conveyor is here illustrated. The machine is operated either by electric motor or gasoline engine power and is called the scoop conveyor because the conveying belt receives its material through a scoop which can be pushed or completely buried in the material to be conveyed. The object of the scoop conveyor is to provide a portable machine that can be readily handled by one man for the purpose of loading and unloading and stacking and re-



PORTABLE BELT SCOOP CONVEYOR.

claiming loose materials such as crushed stone, sand, gravel, coal, coke, ashes, etc. The conveyor has a wide range of application. The manufacturers of this conveyor claim that it will also handle sacks and packages, boxes and various manufactured products and that one operator and the conveyor will handle loose materials at the rate of one ton in 1½ minutes. Keeping cars and trucks moving and cutting the cost of men shoveling are highly desirable in present war-time conditions and this machine will do much to accomplish these ends.

Portable Asphalt Plants Retain Popularity

While in the city of Chicago stationary asphalt plants are much used, the portable type is a favorite in the near-by cities and towns. During the construction season of 1917 these portable plants were much used in the Chicago territory. The R. F. Conway Company operated two Cummer plants last year, one of the railroad and the other of the portable type. They laid 90,000 sq. yds. with the former and 75,000 sq. yds. with the latter. The work was done in Cicero, Joliet and Berwyn, Ill. Transportation of the materials to the plant was by rail in all cases, and the prepared paving material was hauled from the plant exclusively by motor truck for an average distance of 3 miles. Ten trucks were used, mostly Macks of 7½ tons capacity. The average daily run of the portable plant was 1,800 yds. binder and surface complete. On asphaltic concrete the average daily run of the portable plant was 2,200 yds. The corresponding maximum figures were 2,100 and 2,700 yds., respectively. In operating the portable plant the gang organization was as follows: 4 to 5 men shoveling to machine, 4 rakers, 2 rollermen, 2 tampers, 1 smoother, 1 foreman, 2 engineers and 2 or 3 extra laborers. The plant was operated from team tracks. Both Mexican and Trinidad asphalts were used. Coal was used for the melting and other purposes on the Joliet work because of limited oil storage facilities. At Cicero coal was used for the melting and oil for the boilers and drums. The use of oil for the drums is 20 per cent. more efficient than coal, as it makes a quick heat, thereby shortening the warming-up and cooling-off periods. On this class of work the Conway Company have found motor haulage 25 per cent. less expensive than horse haulage.

The White Construction Company, of Milwaukee, have also used portable plants extensively for the past five years. Last year they used two Cummer portable plants on work in South Bend, Ind., and Portage and Milwaukee, Wis. They placed 270,000 yds. with the two plants. Mr. White says that an average annual output for one of these portable plants is 175,000 sq. yds., and one year in Milwaukee he laid 200,000 sq. yds. from one plant. He has operated three Cummer plants during the last five years.

H. G. Goelitz, contractor on municipal work, Oak Park, Ill., laid 70,000 yds. last year with a Cummer portable plant. This work was done in Oak Park, Berwyn, Cicero and Evanston, Ill. Trinidad asphalt was used. In all cases he handled these jobs from grading to final paving, using a Keystone shovel extensively on the grading. A 6-in. concrete base was laid in all cases, and on this was laid 2 ins. of asphaltic concrete, with the exception of one Evanston street, where 3 ins. of sheet asphalt was laid. He has operated a Cummer plant three years and a Merriman car plant one year. Like the other contractors, he is especially enthusiastic about the dryer on the Cummer plant. He operated this year exclusively from team tracks, unloading direct to the plant. Both horse and motor haulage were employed in hauling the prepared materials. The wagons were of the dump variety and rendered good service. Three Garford 7-ton trucks were used, the average haul being 2 miles. His daily average yardage was 1,000 and his maximum 1,800. There were many delays due to the abnormal labor conditions.

In the big cities where streets are paved in "systems"—that is, when many blocks on adjacent streets are paved simultaneously—the stationary asphalt plant is popular. In the smaller cities and on highways—that is, where the pavement runs to great length in proportion to the total yardage placed—the portable plant possesses advantages and fills a distinct field of usefulness.

LIGHTS AND SHADES

The High Cost of Pick Handles

Two sons of Erin were digging a ditch for a gas-main. One of them was slightly handicapped by the shortness of the handle on his pick. His back was aching from bending over so far and he had paused for a moment, when his companion remarked:

"Say, Mike, phwat wud ye do ef ye had a million dollars?"

"I'd add four inches to the handle o' this pick," was the reply.

Gambling on the Green is Out of Date

Time was when the youths and maidens gamboled on the green. Greens were plentiful in those days. Now we have paved areas instead and many children have no playground but the paved street. Recently we saw a picture of an exciting tennis match played on a smooth brick pavement. Now comes word of a dance on a bitulithic pavement in Grinnell, Iowa. This dance was conducted by the "Best People on Earth" and their ladies. A half block of the pavement was roped off and those who know say it was an excellent dancing floor. A flashlight picture of the dancers was taken and sent to Contractor Harrabin who built this pavement eight years ago.

Unique Identification

In a certain central city, celebrated for the excellence of its water purification and sewage treatment plants, two brothers have made fine records by their skillful and progressive methods of operating these plants. Brother C. P. has charge of the water purification plant and brother C. B. of the sewage treatment plant. Naturally sanitarians often confused the two names, so a unique means of identification was suggested, by an eminent sanitarian, running thus: C. P., chemically pure, in charge of water purification plant; C. B., chemically bad, in charge of sewage treatment plant.

The Value of Pure Water

Engineers oftentimes have occasion to address the public on the value of a pure public water supply. Here is an illustration that may be helpful. It is the custom, we believe, to use distilled water in electric storage batteries, but in a certain city, which has a modern water purifying and softening plant, the electrical supply houses simply turn on the tap and sell the city water for 25 cts. per gallon as distilled water and get away with it. The tap water is as good as distilled or it wouldn't work.

The Origin of a Utility Baron

J. B. Quigley, working as a surveyor in his younger days, happened to fall into a water-hole. Down at the bottom the water was frigid; but on the surface it was warm. An idea came to Quigley for a new kind of water-cooler—one that would not allow the ice to float on the surface in contact with the warm water. He invented it. The Missouri Pacific tried it out, found it saved ice, and bought it for $12,000. Quigley used the $12,000 to start out as a promoter, and at one time was president of twenty-five different public-utility corporations—all from falling into a soft place and getting the habit.

Damper Than a Deckhand on a Submarine

An affluent American contractor in London went to have a look at the Thames. There was a steam shovel dredging in the river and he stood watching it——wondering how his shovels back home were working. Suddenly he felt a tap on his shoulder and turned to face a young lad, fresh from the Emerald Isle. "Say," said the youth, "isn't London a wonderful place? By gorry, now just look at that thing goin' down there; now, look at it; isn't that wonderful? But, say I wouldn't want to be the man at the bottom filling that thing up."

Don't be Deceived by a Monocle

To show what a good sport that young English officer is, here is a typical one coming down the road; he is a captain of engineers. He is swinging his little cane, his eyeglass in his eye, and he meets a Canadian sergeant and four or five men, and it may be these Canadian boys had been drinking something stronger than water, otherwise the sergeant would not have been guilty of the grave discourtesy he showed his superior officer.

Said the officer: "Sergeant, by the way, can you tell me the road to—my word, I have forgotten the place, but can you tell me the road?" The sergeant pulled out a big Belgian penny, just about the size of an American fifty-cent piece, only made of copper; he carefully screwed this Belgian penny in his eye and he said, "No, sir, I cannot tell you the road there."

Now, that young officer might have arrested that sergeant, had his stripes torn from him and reduced him to the ranks, and earned the ill will of his companions and perhaps of many Canadians. But he looked at that sergeant for a moment with his eyeglass, dropped his eyeglass out of his eye into the palm of his hand, flipped it up into the air, and unaided caught it in his eye, looked at the sergeant and said, "Aw, aw, do that, you blighter, do that, you blighter." Oh, you have got to know the Englishman in war before you really appreciate him.

The Alderman Retorts

A contractor was excitedly urging upon a Chicago alderman the perfectly good reasons why the city should continue making public improvements during the war. The alderman listened closely—just as if he were being told something for the first time. "Say," said the contractor, "didn't you read all those letters, signed by taxpayers, published in The Friend of the People, in the Tribune this morning?" "Did you write those letters yourself, Charlie?" asked the alderman, and the laugh that went up from the contractors and material men present was a roaring shout.

Mr. Perch Meet Mr. Carp

Some misguided engineer has exhumed the perch from its tomb. Like the carp, the perch is in wrong. This engineer, a road engineer, in calling for bids, scheduled his quantities by the perch. What is a perch, Who knows? It has a different meaning in every locality, and that is why it was abandoned more than thirty years ago in favor of the cubic yard, which is a model of constancy.

FIRE ENGINEERING

Procedure in Maintenance of Fire Hydrants in Minneapolis

In Minneapolis fire hydrants are set with the center of the branch 8 ft. below the street grade. There are 5,627 in service and to maintain them in proper working condition 70,202 inspections were made last year, which gives an average of 12 visits or inspections per hydrant per year.

The maintenance of hydrants consists of testing, replacing valve leathers and other parts, oiling and painting. Constant inspection is necessary during the winter to see that the hydrants do not become frozen. In the congested value districts hydrants are inspected daily in the winter. In residential districts hydrants are inspected once each week. Sometimes it is necessary to uncover hydrants so they can be found after heavy snowfalls.

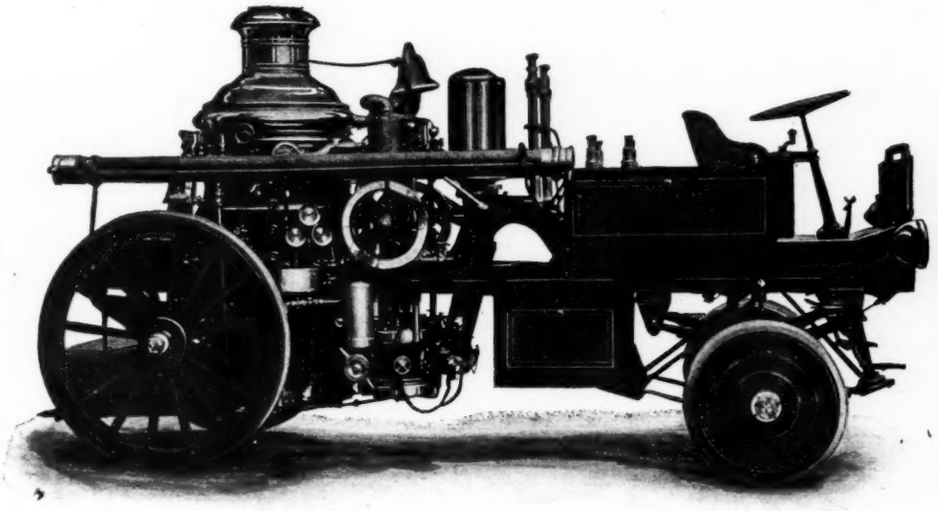
The inspector tests the hydrant for frost in various ways. Sounding by the hand and test by plummet usually reveal any trouble that may require further attention, such as operating the hydrant or using thawing appliances. The cost of inspection work was 6.9 ct. per hydrant for the year. Large buildings which extend their area walls to the curb encroach on hydrant space. The regulations require the hydrants to be walled off from the basements in such cases to keep out the drip water. Where the basements are not heated the cold walls in this climate afford favorable conditions for frost penetration by following down the masonry to the base of the hydrants. In the congested districts hydrant branches occasionally freeze if the branch is close to a catchbasin or manhole. The practice of locating hydrants on the property line at street intersections was abandoned several years ago. Now they are set back 10 ft. from the property line, thus keeping clear of the space usually occupied by catchbasins. All hydrants in use are of the Mathews type. Originally, even in this climate, it was thought necessary either to set the hydrants in brick chambers protected by shavings or to use the common form of iron frost jackets. For the past 7 years a type of hydrant has been in use which has no frost jacket or chamber. The hydrant is buried in the usual way and gives no more trouble than hydrants set according to former methods. The working parts can be removed by removing the bonnet and raising them by means of tripod, which, of course, must be quite high for a hydrant buried 8 ft.

An Electric Steamer's Record

Steamer No. 217 of the New York City fire department, stationed at De Kalb and Lewis avenues, Brooklyn, is said to have been the first electrically-driven piece of fire apparatus put into service in this country. That was only a few years ago, and it was generally predicted that six months' time would see the "new-fangled thing" on the scrap heap. Despite these forebodings, however, the engine is still at work, and its record may well be studied by anyone who still is skeptical of electric fire apparatus efficiency and practicability.

No. 217 was originally a horse-drawn steamer of the largest size, but was converted to the motor type by the removal of its forward running gear and the substitution of a couple gear tractor and a storage battery.

This transformation cost $4,000, and it gave New York City an engine which would have cost not less than $10,000 had new apparatus been purchased. In other words, a dependable steam pumper was continued in service with added speed and a greatly enlarged radius of operation.



COUPLE-GEAR CHASSIS AS USED IN MOTORIZATION OF HORSE-DRAWN STEAMER BY THE CITY OF GRAND RAPIDS, MICHIGAN.

With the exception of battery renewals and replacement of minor parts, No. 217 stands today just as it did when first it went into service on April 24, 1912. The bills for repairs and renewals during the two years have come to just $744.29, $486.97 of which was for battery renewals that were made after the machine had been in service a year and a half. The balance includes minor parts, labor and decorating for the engine to take part in two street parades. Adding depreciation and the cost of charging, operation of this engine has cost the city just $1,370.03.

The cost of motive power for this same type of engine, but with horse instead of battery, is $1,469.06 for two years. These figures are based on the records of two companies, which ordinarily respond to about the same number of calls as No. 217. The sum includes depreciation on horses and harness and stable equipment, which at 10 per cent. is $105.98 a year.

Feed, shoes and veterinary service for three horses cost $516.86, while the repairs vary. As a rule, better service costs more money. In this case the fire department not only has a better piece of apparatus, but one on which it is saving money. The economy claim is supported by the records of the department—the claim of superiority is based on the actual performance of the engine.

In the case of fire fighting this is rated principally by the speed in getting to the blaze. To begin with, the engine saves time in getting out of the house, for there are no horses to harness. Incidentally the passing of the horse has done away with the stalls, and the space thus saved is utilized for garaging the car of one of the department chaplains. With no time lost in harnessing and with the greater speed thru the streets and a wider range of operation, No. 217 is often the first engine at hydrants, to which in the days of the horses it was due third. Considering these things, is it odd that the skeptic has since become a convert?

PERSONAL ITEMS

E. L. GASTIN was recently appointed City Engineer of Macon, Ga.

LEWIS B. SEBRING has recently been appointed City Engineer of Schenectady, N. Y.

WARREN R. NEEL was recently appointed Chief Engineer of the State Highway Department in Georgia.

GEO. S. PIERSON, of Kalamazoo, Mich., has been appointed County Highway Engineer of Kalamazoo County.

L. M. RUSSELL, of Elkhart, Indiana, and Arthur J. Sweet, Consulting Engineer of Milwaukee, Wis., are now associated in business at the latter place. Mr. Russel was formerly City Engineer of Elkhart, Indiana.

J. F. BOWAN has been reappointed City Engineer of Manchester, Conn.

J. J. LAVERY was recently appointed City Engineer of Summit, New Jersey. He was formerly City Engineer of White Plains, New York.

ALFRED D. BUTLER, formerly Assistant City Engineer of Spokane, Wash., has been appointed City Engineer to succeed Morton Macartney, who resigned the position of City Engineer to enter private consulting practice.

PROF. R. C. YEOMANS, for many years Dean of the Engineering Department at Valparaiso University, Valparaiso, Ind., has been appointed Assistant Professor of Highway Engineering of Purdue University to succeed Prof. D. E. Martin, now with the U. S. Engineer corps.

THOS. W. COTHRAN has been appointed by the Governor of South Carolina as Chairman of the State Highway Commission to succeed Major J. Monroe Johnson, now at the head of the South Carolina Battalion of Army Engineers. Mr. Cothran is a trained civil engineer.

C. M. OSBORN has been appointed City Manager of East Cleveland, Ohio, a suburb of Cleveland. For the past 10 years Mr. Osborn was City Engineer of Lorrain.

CHALMERS MILLER, for two years Asst. City Engineer in Lorrain, Ohio, has been appointed City Engineer to succeed C. M. Osborn, who resigned.

J. H. HALLETT has been appointed Asst. City Engineer of Jackson, North Carolina. He was formerly Chief Clerk of the City Engineering Department.

M. HANNAH has been appointed County Engineer of McLennan County, Texas, to succeed R. J. Windrow, who recently resigned this position to become State Water Engineer. Mr. Hannah was formerly County Engineer of Lamar County and later Assistant County Engineer of McLennan County.

PROF. J. MADISON PORTER, for 28 years Professor of Civil Engineering at Lafayette College, has resigned to devote all of his time to other business. He is succeeded in this position by A. H. Fuller.

R. W. GERHART has been appointed County Engineer of Linn County, Iowa. He resigned the office of County Engineer of Buchanan County to accept his present position.

H. LESTER NEWHALL is now principal assistant to the Chief Engineer of the Akron, Ohio, waterworks system. He was formerly Assistant Engineer of the Public Service Commission of New York.

J. B. MARCELLUS has been appointed State Drainage and Consulting Engineer of Kansas, with offices at Manhattan. He was recently in charge of the work of the Portland Cement Assn., at Kansas City, Mo. In his present position his work will be in connection with the extension division of the Kansas State College of Agriculture and the Mechanical Arts.

L. H. POWELL, City Engineer of Tyler, Texas, has been appointed as consulting engineer for road district No. 1, Sheridan County, Texas, also.

H. C. ALLEN of Wallace, Idaho, was recently appointed State Highway Engineer to succeed E. M. Booth. Mr. Booth held the position for 2½ years and resigned to enter the Army Engineering Service.

HALL MOLLITOR, superintendent of operation of the sewage treatment plant at Chatham, New Jersey, has been reappointed to that position for another year.

GEO. C. HABERMEYER, of Urbana, Ill., has been appointed acting Director of the Illinois State Water Survey, and acting Secretary of the Illinois Section of the American Water Works Association, to serve in place of Prof. Edw. Bartow, who is now in Military Service.

W. B. DUBNY has been appointed Highway Engineer of the Monticello, Miss., District to succeed E. B. Blanchard, who has removed to Yazoo City, Miss., where he will act as Highway Engineer.

M. M. COOK has been elected City Engineer of Wichita Falls, Texas, to succeed L. C. Hinckley, who died recently.

DONALD M. BAKER was recently appointed Engineer of the California State Water Commission. He was formerly Deputy County Surveyor in Orange County, California.

BURDETTE WOODYARD of Parkersburg, W. V., was recently appointed State Inspector of Roads for the State Highway Department of W. Va. Mr. Woodyard has had much experience in the construction of concrete roads in particular, notably in Wood County.

HALE JUDSON has been promoted from Assistant Engineer to City Engineer of St. Joseph, Mo., to succeed Carl B. Hoof, who resigned.

M. C. EADES, Chairman of the Alaskan Engineering Commission, will spend the winter in Washington, D. C. He will go before Congress to present the claims of the Alaskan Railroad for appropriations for the year 1918.

CHAS. C. HUFFINE was recently appointed City Civil Engineer of Frankfort, Indiana.

H. GORDON HINKLE has been appointed City Manager of Altoona, Pa. He was formerly County Engineer of Blair County, Pa.

C. G. YOUNG has entered the organization of Ford, Bacon & Davis, New York, where he will devote his time principally to making reports and appraisals of public utility and industrial projects and properties. He has been well known for years in the Public Utility field.

F. H. WILLIAMS, formerly City Manager of Brownsville, Texas, has resigned his position because of poor health. A successor will be appointed at once.

CALVIN W. HENDRICK, formerly Chief Engineer of the city of Baltimore, Md., who built Baltimore's comprehensive sewage collection and disposal works, has become the President and General Manager of the W. Virginia Coal & Timber Co., a $600,000 corporation recently organized by business men of Baltimore. The company has acquired and will develop 32,000 acres of coal and timber land in W. Virginia. Before going to Baltimore Mr. Hendricks had charge of the reconstruction of the sewage collection system in New York City.

R. D. LEE has been appointed City Engineer of Hutchinson, Kans., to succeed G. L. McLane, who is now in the U. S. Army Engineer Corps.

MATT GRAHAM has been appointed City Manager and City Engineer of Augusta, Kansas. He was in the employ of Black & Veatch, Consulting Engineers, of Kansas City, for six years and later was with the Western Brick Manufacturers Association.

BERT W. WELLS has been appointed City Manager of Eldorado, Kans. For eight years he was City Engineer of Wichita, where he has been succeeded by P. F. Brockway, formerly Assistant City Engineer.

NEIL COVENTRY was recently appointed City Engineer, Harrison, Idaho.

CAPT. H. S. BAKER, Construction Quartermaster at Camp Bowie, Fort Worth, Texas, who is principal assistant City Engineer of Chicago, on furlough, has been commissioned as a Lieut. Col. of Engineers in the National Army.

CHAIRMAN BENSON, of the Oregon State Highway Commission, has announced that Oregon will continue work on all highway projects this year.

A. J. MELTON, President of the United Contracting Co., has just finished 1½ miles of road near Vancouver, Wash. This is a 4 in. concrete base, with a 2 in. bitulithic top.

CHAS. H. CLIFFORD, formerly Superintendent of Streets in Portland, Maine, is now a Capt. of Engineers in the National Army.

L. C. CLARK, County Engineer of Leavenworth County, Kansas, called a County Road Meeting late in November, which proved to be a well-planned and enthusiastic county meeting. Practically every highway official and good roads enthusiast in the county attended.

W. S. KING, well known through the middle Southern States as a government building contractor and who has had contracts for over 50 such buildings, and D. J. McCanne, a well known Civil and Electrical Engineer of Denver, Colo., have formed the firm of McCanne-King Co., in El Paso, Texas. They have installed heating and plumbing equipment in numerous large buildings.

JOHN H. GREGORY, Consulting Engineer, 170 Broadway, New York, has been employed by the Board of City Commissioners of Fort Worth, Texas, to prepare plans for the enlargement of the City Water Filtration Plant. The addition will consist of rapid filters, new settling basins, mixing chamber, chemical house and aeration.

GUSTAVE R. TUSKA, Consulting Engineer, of New York City, formerly Chief Engineer of the Panama Railroad Co., and lecturer in Engineering at Columbia University, has been commissioned as Major in the Engineer Section of the Officers' Reserve Corps of the United States Army.

COMING CONVENTIONS

NEW JERSEY STATE LEAGUE OF MUNICIPALITIES—Annual convention at Trenton, Jan. 3-4. Sec'y, Clinton A. Swartz, Trenton.

NORTHWESTERN SOCIETY OF HIGHWAY ENGINEERS—Annual convention at Benson Hotel, Portland, Ore. Sec'y, C. G. Reiter, Hillsboro, Oregon.

VIRGINIA GOOD ROADS ASSOCIATION—Annual convention at Richmond, Jan. 15-17, 1918. Sec'y, C. B. Scott, Richmond.

AMERICAN WOOD PRESERVERS' ASSOCIATION—Annual convention at Chicago, Jan. 22-24. Sec'y, F. J. Angier, Baltimore & Ohio Railroad, Mount Royal Station, Baltimore, Md.

AMERICAN CONCRETE INSTITUTE—Annual meeting at Chicago, Feb. 7-9. Sec'y, Harold D. Hynds, 27 School St., Boston, Mass.

CONTRACTORS AND BUILDERS SHOW—Supersedes annual Chicago Cement Show. To be held under auspices of the National Exhibition Co., 123 West Madison St., at the Coliseum, Feb. 6-13, 1918.

AMERICAN CONCRETE PIPE ASSOCIATION—Annual convention at Hotel Sherman, Chicago, Feb. 8-9. Sec'y, J. H. Libberton, 208 S. LaSalle St., Chicago.

IOWA ENGINEERING SOCIETY—Annual meeting at Waterloo, Feb. 20-21. Sec'y, J. H. Dunlap, Iowa City, Ia.

UNITED STATES GOOD ROADS MACHINERY EXHIBIT—Exhibit at Little Rock, Ark., April 15-19. Sec'y J. A. Rountree, 1,021 Brown-Marx Bldg., Birmingham, Ala.

UNITED STATES GOOD ROADS ASSOCIATION—Will convene in Little Rock, Ark., April 15-17. U. S. Senator J. H. Bankhead, Pres. Sec'y, J. A. Rountree, 1,021 Brown-Marx Bldg., Birmingham, Ala.

BANKHEAD NATIONAL HIGHWAY ASSOCIATION—Will convene in Little Rock, Ark., April 18-19. T. S. Plowman, Pres. Sec'y, J. A. Rountree, 1021 Brown-Marx Bldg., Birmingham, Ala.

CATALOG REVIEWS

Turbine Pumps.—Turbine pumps for high head service. Issued by Worthington Pump and Machinery Corporation, 115 Broadway, New York; 6x9 ins.; 32 pp. Illustrates and describes pumps, explains principle of operation and discusses characteristics of turbine pumps. Gives field of application, including fire and water service.

Volute Centrifugal Pumps.—Issued by Worthington Pump and Machinery Corporation. 6x9 ins.; 32 pp. Illustrates and describes pumps of this class, of both single and double suction. Discusses direct-connected, belt-driven, vertical shaft and geared turbine driven pumps. Shows application to water works service, sewage pumping and irrigation and drainage service.

Power Machinery.—Rotary converters, motor generator sets and frequency changes. Issued by MacGovern & Co., 114 Liberty St., New York. 9x14 ins.; 10 pp. Lists machinery in stock for prompt shipment.

Water Meters.—Worthington meters. Issued by Worthington Pump and Machinery Corporation. 6x9 ins.; 12 pp. Illustrates and describes the Worthington flat disc meter. Lists parts and gives instructions for reading meters. Also shows Worthington fish trap.

Concrete Spouting Equipment.—Illustrates, describes and shows application of this equipment. Issued by H. B. Sackett Screen & Chute Co., 1679 Elston Ave., Chicago. 6x9 ins.; 16 pp. Shows plant layouts, hoists, hoppers, buckets, chutes, spouts and concreting carts, buckets, cars, etc. Also portable track and switches.

Concrete Highway Construction.—Issued by the Atlas Portland Cement Company, New York. 8½x11 ins.; 24 pp. Enumerates essentials of a good highway. Gives illustrated general description of concrete road design and construction. Gives equipment and organization required. Gives itemized proposals for concrete road construction and tells how to fill them out intelligently.

Labor-Saving Equipment.—Catalog and price list of the Lee Line of labor-saving equipment used for hauling loose materials, including Lee loaders and dump bodies for motor trucks, trailers and wagons. Issued by Lee Loader & Body Co., 2343 S. La Salle St., Chicago.

Concrete Mixers.—The Archer special mixer illustrated and described. Issued by the Archer Iron Works, 34th Place and Western Ave., Chicago. 6x9 ins.; 16 pp. Shows advantages of portability and end-discharge.

Ultra-Violet Ray Sterilizers.—Issued by the R. U. V. Co., Inc., New York. 8½x11¼ ins. Discusses water sterilization by this method and illustrates and describes the requisite equipment. Bulletins Nos. 1 to 6, inclusive.

Sewage Siphons.—Miller siphons for flushing sewers and for handling sewage in treatment plants and elsewhere. Issued by the Pacific Flush Tank Co., 149 Broadway, New York. Explains principles of operation. Gives suggestions for flush tank specifications. Discusses Jointite for joining sewer pipes. Takes up sewage disposal with reference to domestic installations, sand filters, alternating and time-controlled apparatus, contact beds, sprinkling filters, Taylor nozzles and Imhoff tanks.

Water Chlorination.—Pamphlets issued by Wallace & Tiernan Co., Inc., New York, entitled: Protecting the Water Supply of Greater New York; Automatic Liquid Chlorine Water Disinfecting Plant; Wallace & Tiernan Bacteriological Testing Outfit; Why; and, Chlorination at Dunwoodie. Consists of general and specific information on the sterilization of public water supplies by application of liquid chlorine. Gives technique of application and illustrates requisite apparatus. Gives operating data.

TRADE NOTES

Forrest J. Alvin, general manager of the United States Motor Truck Company of Cincinnati, recently announced plans of the company to greatly increase its production for 1918 with a consequent increase in sales distribution. The company is now closing with wide-awake distributors who have hitherto been unable to secure trucks from the company which was unwilling to make the appointments until prepared to deliver on schedule.

W. Owen Thomas, the consulting engineer of Detroit, says that America will have need for every motor truck ordered for service in America and over seas in connection with the war. Mr. Thomas was chief of mechanical transport for the Canadian army for two years and General Sir Sam Hughes credited the Detroiter with putting Canada at the front a year ahead of its time.

B. F. Affleck, Chicago, was re-elected president of the Portland Cement Association at its annual meeting at the Hotel Biltmore, New York, December 12. Mr. Affleck is president of the Universal Portland Cement Co. The Portland Cement Association has turned its activities largely to the promotion of permanent roads, in line with the desire of the Council of National Defense that through routes be quickly developed to supplement the railways, especially for short-haul traffic. F. W. Kelley, president, Helderberg Cement Co., Albany, N. Y., was elected first vice president, and Richard Hardy, president, Dixie Portland Cement Co., Chattanooga, Second Vice President. G. S. Brown, president, Alpha Portland Cement Co., Easton, Pa., was elected treasurer.

L. F. Hamilton, for several years manager of the advertising department of the National Tube Co., Pittsburgh, has accepted a similar position with the Walworth Mfg. Co., Boston, which, on August 1, purchased the Kewanee works of the National Tube Co. Mr. Hamilton was born in Kewanee, Ill. He was graduated from the University of Illinois in 1897. He was with the Western Tube Co. until 1908, advancing from claim department and secretary to sales manager. From 1908 to 1917 he was with the National Tube Co. He was identified with the advertising success of the "Kewanee" union, the "Shelby" tubing and the "National" pipe. He has been a contributor to advertising periodicals and speaker on advertising subjects. Several technical advertising men are graduates from National Tube Co. Advertising Department, obtaining their training under Mr. Hamilton, including: W. A. Phillis, advertising manager the Borden Co., Warren, O.; Wm. J. S. Ritscher, advertising manager Petroleum Iron Works Co. of Ohio, Sharon, Pa.; G. E. Land, advertising manager Blaw-Knox Co., Pittsburgh, Pa.

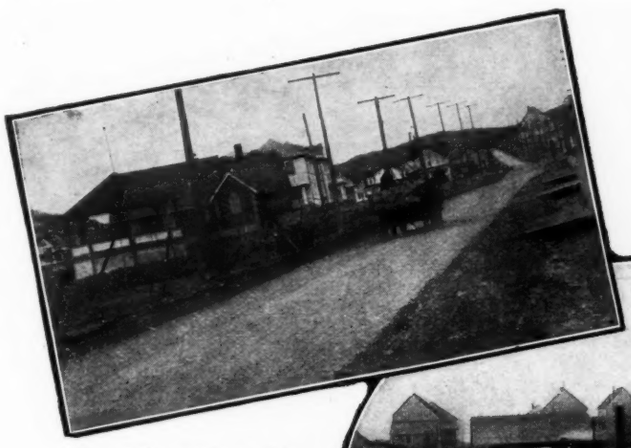
Using Dynamite in Ditching Wet Spots

Ordinarily the construction of proper drainage ditches in wet, soggy ground is a very difficult matter. Horses, tractors and machinery can seldom be used on account of getting mired in the mud and hand labor is entirely too scarce and expensive to be used for such purposes.

One very successful road contractor uses large amounts of dynamite in general road work and finds it of great assistance in ditching these wet spots. He uses the electrical method of firing, making the holes about 6 in. shallower than the grade line desired and placing them about 30 in. apart along the center line of the proposed ditch. The charges of dynamite are primed with an electric blasting cap, placed in the holes and well tamped. The electric cap wires are connected up in series and fired by a blasting machine. In this manner the entire line of charges explodes at the same instant, lifting the dirt high in the air and scattering it over the surrounding land, thus doing away with high banks of earth along the ditch.

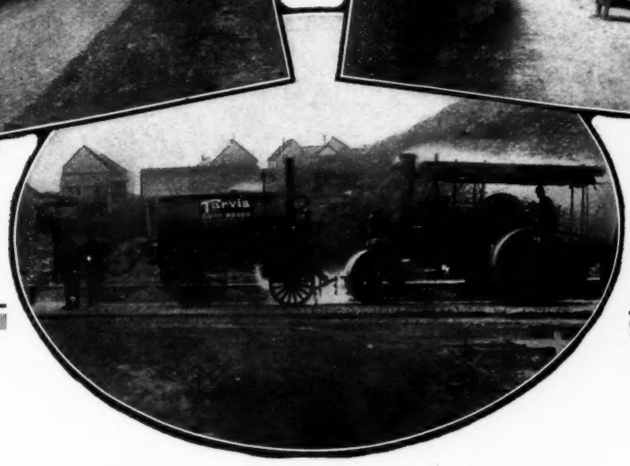
He has become so successful at this kind of work that by proper loading there is no hand work to be done after the blast, as the ditch is left clean and clear of all debris, ready for immediate use. A ditch averaging 4 ft. deep and 8 ft. wide on top can be made in this manner without the aid of a shovel of any kind. From 1 to 1½ lbs. of 40 per cent low-freezing dynamite per hole is sufficient loading for this size of ditch in heavy soil.

The contractor claims that this method is most satisfactory from his standpoint on account of economy, because of its quickness and because of the saving in hand labor, which at this time of serious labor shortage is an all-important item.



One of the many streets in Coppercliff, Ontario, treated with "Tarvia-B," 1917.

Sudbury-Coppercliff Road, Ontario, three and a half miles long. Resurfaced in 1916 with three-inch "Tarvia-X" top, three-coat method.



Applying "Tarvia-X." Sudbury-Coppercliff Road, Ontario, 1917.

Frost-proof Roads in the "Frozen North"

Winter temperatures in the Algoma district in northern Ontario are so severe that few road-making materials can withstand them.

Tarvia does!

Under the severest tests, Tarvia has proved itself frost-proof, mud-proof and traffic-proof, regardless of long-continued zero weather or other equally rigorous climatic conditions.

The Sudbury-Coppercliff Road pictured above is three and a half miles long. It carries a very heavy wagon traffic. It has a three-inch Tarvia surface, making it impervious to the wear of traffic, the effects of the severe northern winter, and to the equally trying spring thaw when ordinary roads soon become impassable.

Tarvia is a coal-tar preparation shipped in barrels or in tank-cars.

Tarvia
Preserves Roads
Prevents Dust

It is made in several grades for varying road conditions.

"Tarvia-A" is applied hot for resurfacing a road already built.

"Tarvia-B" is used cold. It sinks readily into the road-surface, yet is strong enough to bind it firmly together. It is the cheapest form of road maintenance yet invented.

"Tarvia-X" is to be used in constructing a new road.

Macadam roads treated with Tarvia are durable, smooth, mudless, dustless, frost-proof and water-proof.

Used in place of water as a binder, it makes a lasting, resilient road-surface that will not grind to powder under automobile or horse-drawn traffic.

Booklets describing the Tarvia treatments free upon request.

Special Service Department.

This company has a corps of trained engineers and chemists who have given years of study to modern road problems.

The advice of these men may be had for the asking by any one interested.

If you will write to the nearest office regarding road problems and conditions in your vicinity, the matter will have prompt attention.

The Barrett Company

New York, Chicago, Philadelphia, Boston, St. Louis, Cleveland, Cincinnati, Pittsburgh, Detroit, Birmingham, Kansas City, Minneapolis, Nashville, Salt Lake City, Seattle, Peoria

THE BARRETT COMPANY, LIMITED: Montreal, Toronto, Winnipeg, Vancouver, St. John, N. B., Halifax, N. S., Sydney, N. S.

TRADE B MARK

CONTRACT NEWS

CONTRACTS AWARDED

ROADS AND PAVEMENTS.

Ariz., Globe—R. O. Black, Clifton, was awarded contr. for bldg. Sec. 2, El Capitan Rd., at $70,900.

Ariz., Hayden—R. O. Black, Clifton, awarded contr. for construct'g El Capitan sec. of Globe-Hayden Hwy.—12 mi. Gila Co. —at approx. $76,000.

Ark., Conway—Bell Constr. Co., Dallas, awarded contr. by Faulkner Co. Commr. for construc. of gravel rd., Conway to Saltillo, at $48,000.

Ark., Forrest City—Lewelling & Price, Williams, Little Rock, awarded contr. for construct'g. 42 mi. gravel conc. and asphaltic conc. rds., at $253,000.

Cal., Sacramento—Palmer & McBryde, Hooker & Lent Bldg., San Francisco, awarded contr. for bldg. 15.6 mi. hwy—Garberville to Miranda, Humboldt Co.—at $223,555. Blanchard-Brown Co., Call Bldg., San Francisco, awarded contr. for lay'g asph. surface on hwy.—Fresno to Malaga—at $22,824. A. L. McCray, 234 W. 29th St., Los Angeles, awarded contr. for 10 mi. hwy.—San Fernando to Rancho Tujunga—at $111,251.

Cal., Sacramento—A. I. McCray, 422 Am. Bk. Bldg., Los Angeles, awarded contr. for 2.7 mi. grading and conc. paving, in Los Angeles Co., at $111,251.

Cal., San Diego—Fairchild-Gilmore-Wilton Co., Pacific Elc. Bldg., Los Angeles, awarded contr. by Bd. of Supvrs. for bldg. 6 mi. 20-ft. conc. rd.—San Diego to Camp Kearney—at $108,325.

Fla., Tampa—Davis & Webb, Tampa, awarded contr. for bldg. rds. through Polk, Pasco, Manatee and Pinellas Cos., at $860,616.

Colo., Denver—Chas. Connor, 3263 Blake St., city, awarded contr. for construct'g Denver-Littleton Rd., at $73,940. Work involves grading paved rdway 16-ft. wide, culverts and brdgs., etc.

Ga., Fort Oglethorpe—Merrill Rd. Improv. Co., Chattanooga, Tenn., awarded contr. for 4 mi. rd., 24-ft. wide, at about $150,000.

Ill., Joliet—R. F. Conway Co., Cham. of Com. Bldg., Chicago, awarded contr. for paving Jackson St.—Chicago to Collins Sts. —at $29,770.

Ind., Anderson—Sullivan & Sullivan, local, awarded contr. for bldg. Stafford Rd., at $91,000.

Ind., Kendallville—Moellering Constr. Co., Ft. Wayne, Ind., awarded contr. for paving Main St. with conc., at $45,509.

Kans., Augusta—Bossler Constr. Co., Winfield, awarded contr. for paving Augusta St., at $34,000.

Kans., Columbus—D. E. Dorsey, Weir City, awarded contr. for bldg. 10 mi. of rds., at $58,227.

La., Baton Rouge—S. A. Gano, Jackson, Miss., awarded contr. for road construction, at $50,000.

La., Shreveport—Kennedy-Olsen Constr, Co., Kansas City, Kans., awarded contr. by city for paving Olive St.—5th to 21st St.—at $60,000.

Me., Augusta—A. D. Bridges' Sons, Hazardsville, Ct., awarded contr. for construct'g 4.28 mi. state hwy., at $69,340.

Md., Salisbury—W. B. Shafer Constr. Co., local, awarded contr. for constr. conc. rds. at Camp Meade, at $150,000.

Minn., Minneapolis—S. K. Grace & Son, Kansote Bldg., awarded contr. by Hennepin Co. for bldg. Rd. No. 20, Cedar Ave., at about $30,000.

Minn., Princeton—C. A. Pogue, Grand Rapids, awarded contr. for rd. constr. on Fed. Aid Project No. 3, at $69,000—about 40 mi.

Minn., Worthington—Lomoreaux Bros., Omaha, Neb., awarded contr. for graveling; also Job No. 1811, State Rd. No. 1, at $7,589 and $10,335.

Mont., Billings—Warren Constr. Co., city, awarded contr. for laying 13,360 sq. yds. paving Dist. No. 29, at $37,462.

N. J., Freehold—R. Hafeman Co. awarded contr. for bldg. Freehold-West Freehold Rd., at $36,024.

N. J., Newark—Newark Pav'g Co., city, awarded contr. for paving three streets, at $33,831, $10,382 and $15,235, respectively.

N. Y., Long Island City—Sicilian Asph. Paving Co., N. Y. City, awarded contr. for paving portions of Hughes and Hancock Sts., at $10,475 and $11,681.

N.Y., Manhattan—W. J. Fitzgerald, 547 W. 45th St., awarded contr. for wood block repaving on conc. 4th Ave. and Broadway, at $9,235 and $42,658.

Ohio, Canton—F. A. Downs Constr Co., Canton, awarded contr. for bldg. Miner-Robertsville Rd., at $48,781. Elmer Vogt, Massillon, awarded contr. for Brewster-Massillon Rd., at $21,783. Harry Corl, Canton, cont. for Navar-Richville Rd., at $45,032.

Ohio, Cleveland—Roehl Bros., city, were awarded contr. for paving and improv'g Archwood Ave., at $39,387.

Ohio, Napoleon—A. Westrick, Holgate, award. contr. by Henry Co., for 8½ mi. macad.-bound rd., at $83,000.

Okla., Ardmore—Larkin Constr. Co., Dallas, Tex., award. contr. for construc. 13 mi. rd.—rock and gravel surfaces, at $90,997.

Okla, Tulsa—F. P. McCormick, award. contr. for paving several streets, at $325,000.

Ore, Portland—Calvert & Walker, Portland, award, contr. for rebldg. hwy. from Myrtle Crk. to Dillard, Douglas County, at $127.765.

Pa, Allentown—Geo. H. Hardner, City, award. contr. for constr. rdway. on state brdg. across Lehigh River, at $38,342.

Pa, Allentown—Shaffer & Ackerman, City, award, contr. for repairg. w. and rdway. Hamilton St. brdg., at $33,000. 12,000 sq. ft. conc.

Pa., Harrisburg—J. E. Richey, S. W. Cramer, and Jno. Mck. Snow, Franklin, Pa., award. contr. by State Hwy. Com. for bldg. rd. Oil City to Rouseville—through Cornplanter Twp., at $52,888. Road will be 16 ft. wide of vit. blk.

Pa., Philadelphia—J. J. McHugh, City, award, contr. for construc. mrdwa. 17th to 18th Sts., at $47,000.

Pa., Pittsburgh—Neelen & Daly, 214 Fitzsimmons Bldg., award. contr. for grading, curbing and paving several streets, at $10,-917. T. Cronin, S. 17th and Muriel Sts., award. contr. for paving, at $10,317. C. Donatelli, 1313 Collier St., contr., at $15,863.

R. I., Providence—Perrin & Cadario, Boston, award. contr. by State Bd. Pub. Rds., for bldg. sec. State Hwy., S. Kingstown, at $62,660.

S. C., Great Falls—J. T. Blassingame, Greenville, award. contr. for constr. rd., at approx. $100,000.

S. C., Spartanburg—Morrison & Glover, Augusta, award. contr. for layg. surf. on conc. rd. to Camp Wadsworth, at $37,000.

Tex., Dallas—Moberley & Brown, City, award. contr. for constr. of rd. and bldg. earth embankment, at $13,266.

Tex., Houston—Haden & Austin, City, award. contr. to improve Telephone Rd., at $26,070.

Tex., Houston—Horton & Horton, Houston, award. contr. for pavg. streets at Camp Logan, at $84,000.

Tex., Texarkana—Kennedy Constr. Co., award. contr. by City for paving Olive St.—4th to 19th Sts., at $56,000.

Tex., Wheeler—Smith Bros., Crockett, award. contr. for 55 mi. rd. improv. Dist. 2, at $35,000.

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SEWERAGE AND SEWER TREATMENT.

Ariz., Glendale—C. Fisher & Co., 345 N. 6th St., Phoenix, award. contr. for bldg. san. sewerage sys., at $46,797.

Cal., Los Angeles—Magenovitch & Gillespie, 3920 Wisconsin St., City, award. contr. for drainage work in Draining. Dist. No. 2, at $142,982.

Cal., Los Angeles—Mike Chutuk, local, award. contr. for construc. of vitr. pipe san. sewer Stratford Rd.—Avenue 49 to Avenue 51, at $8,209.

Cal., Los Angeles—Andrew Joynich, local, award. contr. for install'g. san. sewer Fayette St. and Adams St., at $6,000.

Cal., Los Angeles—Leo Miletich, city, award. contr. for construct'g. vit. pipe san. sewer in Carlton Way, at $1,349. Adam Dalmatin, city, award. contr. for similar wk. in Hudson Ave., at $4,733.

Cal., Riverside—Johnson-Shea Co., local, award. contr. for construct'g. 306 ft. sewer, at $249,62.

Cal., San Diego—Holland Constr. Co., Granger Bldg., award. contr. for bldg. rein. conc. storm drain, 1084 ft. long, at $24,470.

Cal., Santa Barbara—Magenovitch & Gillespie, 219 Bloom St., Los Angeles, award. contr. for construct'g. intercept'g. sewer sys., at $36,325.

Cal., Waterford—R. Von Voorheis, award. contr. for construct'g. 6 secs. Waterford Irrig. Sys., at $6,000. D. E. Kilroy, local, contr. for construct'g. Secs. 22, 23, and 25, at $6,646.

Conn., Bridgeport—Pierce Mfg. Co., local, award. contr. for construct'g. Bryant, Siemon and Hubbell Sts., trunk sewer, at $13,313; Deacon St. sewer, at $3,459; Taft Ave. sewer, at $1,258. The Burns Co., local, award. contr. for sewer construct. in Bronx Av., at $1,245 and in Ellsworth St., at $1,834. Louis Jacques Constr. Co., award. contr. for sewer construc. Success Av., at $1,595.

D. C., Washington—Geo. Hyman, city, award. contr. for construct'g. sewers in Dist. of Columbia at approx. $3,200.

Ill., Bloomington—J. A. P. Daniels, Ia., award. contr. for construct'g. sewers in following streets and alleys: Mulberry St., at $300; alley and Dry sewer, $625; Linden St., $1,935; Virginia Ave., $432; water main in Linden and Virginia Aves., $5,438.

Ill., Rock Island—Frazer-Davis Constr. Co., St. Louis, Mo., award. contr. by Rock Isl., and Moline, for install'g. 1st half storm drain., at $27,863.

Ind., Indianapolis—Columbia Constr. Co., city, awarded contr. for construc. of sewer on 13th St.—Hillsdale Ave. to School St., at $93,686.

Ia., Ft. Dodge—Berkland & Littell, Eagle Grove, award. contr. for construct'g. drain No. 253 at $22,700.

Iowa. Mason City—S. R. Bowen & Co., award. contr. for laying 2 san. sewers at $2,000.

Kans., Augusta—McCoy & Taylor, Wichita, award. contr. for construct'g. sewers, at $16,000.

Kans., Towanda—C. C. Jamison, Eldorado, award. contr. for construct'g. sewers at $13,000.

Ky., Falmouth—W. L. Nowland & Co., Covington, award. contr. for san. sewer system at $10,000.

Mass., Boston—Anthony Cefalo, local, award. contr. for pipe sewers and drains in Belgrade Ave., Beck St., at $5,165.

Mich., Grand Rapids—Vander Weele Bros., award. contr. by City for sewerage sys., at $76,453—in Secs. No. 1 and No. 4; McDermott & Cooper, contr. for sewers in Sec. No. 2, at $56,296. Ver Hey & Kloet, contr. for sewers in Sec. No. 3, at $46,184.

Mich., Port Huron—Carpenter Constr. Co., 707 Ford Bldg., Detroit, award contr. for bldg. main sewer line in Howard St.—16th to 20th Sts., at $16,865.

Minn., Brainerd—Shirlund Co., Brainerd, award. contr. for construct'g. lateral sewer C5, Dist. No. 3, at $6,072.

Minn., St. Paul—O'Neil & Preston, 66 E. 6th St., city, award. contr. for bldg. Otto-Niles sewerage sys., at $90,000.

Minn., Virginia—Risberg & Marwick, local, award. contr. for bldg. pipe tunnel from Roosevelt School to Technical and new Addn., at $5,652.

Mo., Kans. City—Kinlin Constr. Co., city, award. contr. for construct'g. sewer Div. No. 5, at $11,684.

Mo., Kans. City—Hoover Bros., 17th and Tracy Sts., award. contr. for bldg. sewer in Dist. No. 2, at $59,075.

Mo., Kans. City—C. H. Crosby, local, award. contr. for sewer constr. in Dist. No. 409, at $49,526.

Neb., Lincoln—J. M. Deffenbaugh, local, award. contr. for sewer from Vine St. through Fair Grounds to Salt Crk., at $13,335.

Neb., Omaha—John S. Harrington, 3001 Mason St., award. contr. for constr. of storm sewer at $3,423.

Neb., Omaha—Alex. Beck, Omaha, award. contr. for sewer construc. in Dist. No. 353; and Dist. No. 357, at $20,992, and $17,792 respectively.

N. J., Garwood—E. W. Chamberlain, Westfield, N. J., award. contr. for install. of sewers, at $6,507.

N. Y., Brooklyn—J. F. Cogan, Woolworth Bldg., N. Y. City, award .contr. for Bldg. sewers and sewage pump'g. sta., in Flatlands Ave., at $421,673.

N. Y., New York—Melrose Constr. Co., 147 E. 126th St., city, award. contr. for alter'g. and improv'g. sewer Ann St., at $8,037; 114th St., at $3,222; 121st St., at $3,380. Aliergo Co., 951 Sherman Ave., city, contr. for sewer construc. in W. 163rd St., at $6,305.

N. Y., New York—Jos. J. Halduven, 16 E. 177th St., city, award. contr. for construct'g. sewer in Cedar St., at $5,701.

N. Y., Oneida—Carnavale Bros., 101 Stone St., city, award. contr. for san. sewer Sayles St. and Cleveland Ave. at $2,075.

N. Y., Rochester—F. V. Brotsch Co., E. and B. Bldg., award. contr. for constr. of sewers on Grand Ave., at $25,335.

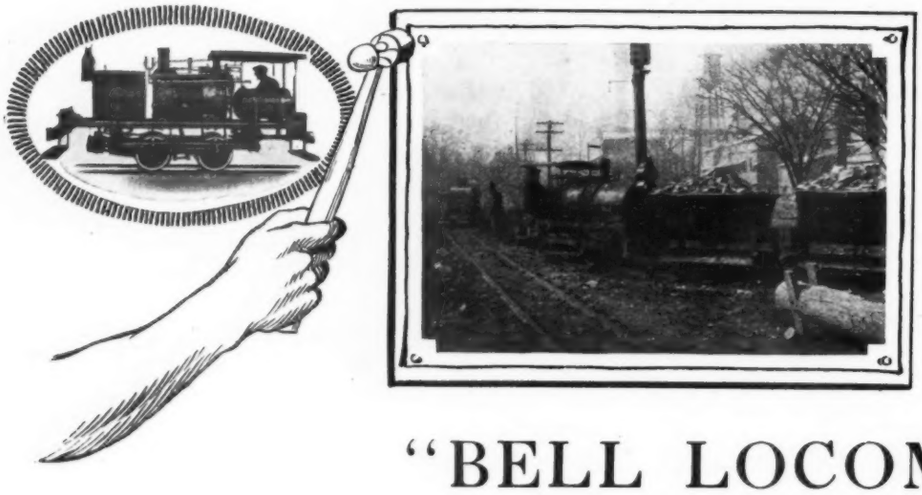
O., Canton—F. A. Downes Constr. Co., award. contr. for storm sewer at $81,000. Burd Constr. Co., award. contr. for Crystal Pk. storm water sewer, at $16,675.

O., Cleveland—Connelly Construc. Co., city, award. contr. to construct intercept'g. sewer—Washington Pk. to sewage disp. plant, Newburg Heights, at $180,785. Sewer will be built of brick.

O., Cuyahoga—C. L. Wright, Mt. Vernon, award. contr. for bldg. san. sewerage sys., at $16,846.

O., Lorain—T. Trifello, 319 13th St., award. contr. for sewer construc. in Allison and Park Aves., and Lake View Blvd., at $11,000.

O., Toledo—Thos. J. Kelly, city, award. contr. for construct'g. sewer in Glendale Ave., at $2,223; in Wylie Ave., at $3,026. J. N. Bick, local, award. contr. for construct'g. sewer in Cherry St., at $26,859.



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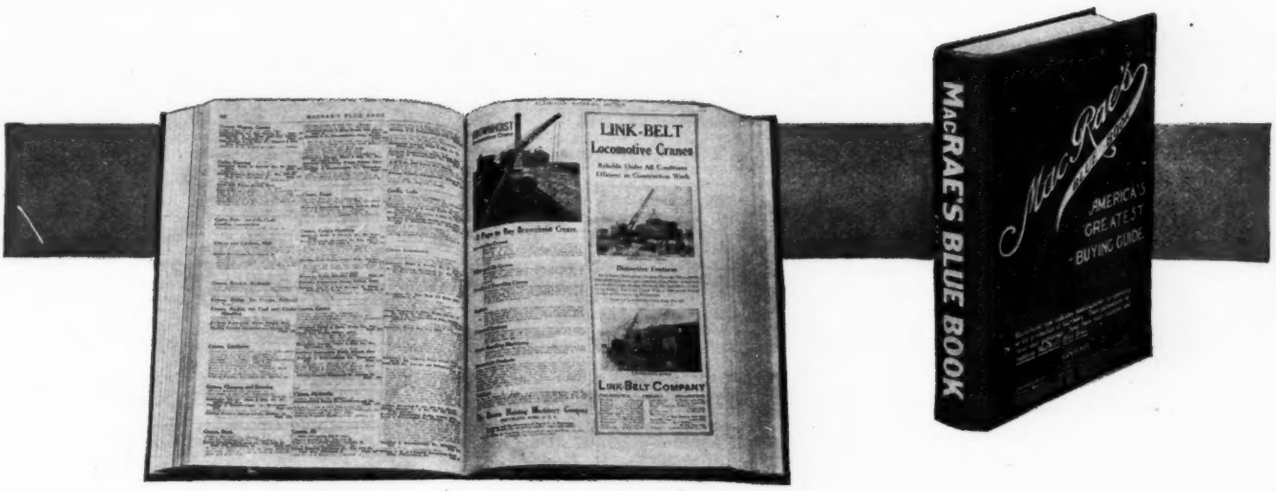
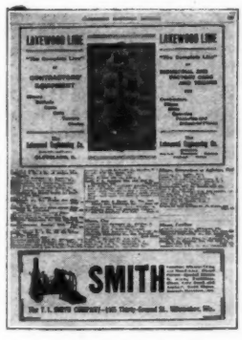
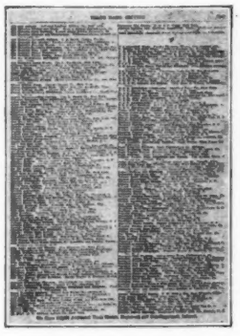


Address Section
The names and addresses of twenty thousand American manufacturers.

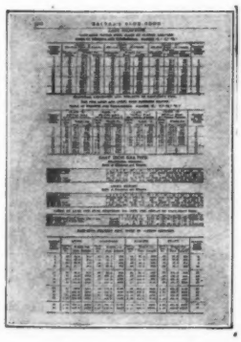
Catalog Section
In condensed form, the catalogs of eight hundred manufacturers.



Classified Section
The names of manufacturers listed under ten thousand classifications of the products they manufacture.



Trade Name Section
Fifteen thousand trade names, showing the names and addresses of concerns manufacturing the articles so tradenamed.



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Railway Exchange **CHICAGO, ILL.**

O., Youngstown—C. Harris, 103 LaClede St., award. contr. for construct'g. sewers in Albert St., at $80,000.

Pa., Erie—H. L. Mead, city, award. contr. for construct'g. 9-in. tile sewer Weschler Ave.—9th to 10th Sts.—at $1,756.

Pa., Oil City,—Lesher & Roess, city, award. contr. for sewers in 10th Ward at $20,413.

Pa., Phoenix—A. H. Rush, local, award. contr. for laying 914 ft. 24-in. sewer, at $1,392.

WATER SUPPLY AND PURIFICATION.

Ill., Kewanee—Jonas Backsell, city, award. contr. for piping at new water works plant, at $5,978.

Kans., Towanda—B. F. Evans, Newton, award. contr. for construc. of water wks. sys., at $25,000.

Ky., Covington—Union Light, Heat & Power Co., city, award. contr. for install'g. new motors and pumping machinery, at $36,000.

Md., Indian Head—E. Christman, 416 McClymonds Bldg., Massillon, O., award. contr. by Bureau of Yds. and Docks, Washington, for constr. of artesian wells at Naval Proving Grounds, at $55,685.

Mass., Boston—M. De Sisto, city, award. contr. for laying and removing water pipes, Commonwealth Ave., at $3,970.

Mich., Grosse Pointe Pk.—R. D. Baker Co., Penobscot Bldg., Detroit, award. contr. for water main constr. at $2,700.

Mo., Moberly—Layne & Bowler, 400 Interstate Bldg., Kans. City, Mo., award. contr. for waterworks and addn. wells, at $30,000.

Neb., Hoskins—Merkle Machinery Co., 1020 Woodmen of World Bldg., Omaha, for engine and pump for waterwks.; contr. for tower and tank to Steel Struc. Wks.; pumphouse, to Farmers' Lbr. Co., Hoskins, $10,000.

Neb., Pender—Wright Elec. Constr. Co., Fremont, award. contr. for water and elec. light plant, at $10,989.

N. D., Langdon—Haggart Constr. Co., Fargo, award. contr. for construct'g. water and sewer sys., at $77,000.

O., Akron—Chicago Brdg. & Iron Wks., award. contr. for construct'g. steel water tank, at $30,580.

O., Canton—Lane & Bowler, Chelsea Ave., Memphis, Tenn., award. contr. for drilling 12 wells, furnishing pipe and screens, at $19,000.

O., Euclid—Gould & Maybach, 823 E. 150th st., Cleveland, award. contr. for bldg. 6 water mains in Independence, Chelcoa, Nautmann, Ivan and Nicholas Aves., at $27,150.

Pa., Philadelphia—Memphis Steel Constr. Co., Pittsburgh, award. contr. for constr. of elevated steel tank and tower at Navy Yd., at $16,484.

Pa., Quinton—R. D. Wood & Co., Philadelphia, award. contr. for install'g. new pumping unit in Salem water wks., at Quinton, at $2,490.

S. C., Columbia—Perry-Mann Elec. Co., 1537 Main St., award. contr. by City for furnishing 1 250 and 2 400-h. p. pumps for water system, at $9,641.

Wash, Bellingham—K. Sauset, local, award. contr. for bldg. dam flume—28 ft. 42-in. creo. wood stave pipe—at $4,339.

Wash., Bremerton—W. B. Lance, Seattle, will probably be award. contr. for construct'g. new reservoir, at $38,000.

BRIDGES AND BUILDINGS.

Cal., Red Bluff—McCartney & Taylor, local, award. contr. for 4 rein. conc. brdgs., at $3,100 and $2,789. Teal & Thompson, Orland, award. contrs., at $7,400 and $9,900.

Colo., Buena Vista—R. P. McDonald award. contr. for rein. conc. brdg. over Arkansas River, at $14,700.

Ct., Canaan—I. J. Sieling, 171 Madison Ave., New York City, award. contr. for rein. conc. arch brdg. over Housatanoic River, at $35,000.

D. C., Washington—Midland Brdg. Co., Kansas City, Mo., award. contr. for furnishing matl. and construct'g. hwy. brdg. in Ute Mt. Reserva, at $10,000.

Idaho, Council—J. H. Forbes, Caldwell, award. contr. for construct'g. steel brdgs. in Adams Co., at $27,075.

Idaho, Grangeville—Security Brdg. Co., Lewiston, award. contr. for construct. of steel and conc. brdg. across Clearwater River at Harpster, at $5,000.

Ind., Logansport—Natl. Conc. Co., Indianapolis, award. contr. for brdg. over Eel River at 3rd St., at $91,317.

Ind., Peru—Rochester Brdg. Co., award. contr. for construct'g. superstruc. on steel brdg. over Pipe Crk., at $10,959. H. B. Converse, Converse, Ind., also award contr. for superstruc., at $1,325.

Iowa, Dedham—Rickens Construc. Co., Sioux City, award. contr. for construc. brdg. betw. town and railroad sta., at $7,200; also Alson Hansmonn brdg. at $5,500.

Ft. Dodge, Ia.—Jensen Constr. Co., local, award. contr. for conc. viaduc on N. 3rd St., at $118,000.

Iowa, Oskaloosa—Clinton Brdg. Wks., Clinton, award. contr. for construct'g. 3 bridges, and Ottumwa Supply & Construc. Co., Ottumwa, for substruc., at $17,701.

Iowa, Sioux City—E. A. Whitney, Sioux City, and Frankman Bros. Brdg. & Constr. Co., 909 Metropolitan Life Bldg., Mpls., award. contr. for 66 ft. steel span brdg., conc. fdn., at $27,642.

Kans., Coffeyville—M. T. Gillotz, Monett, Mo., award. contr. for 7 brdgs., Labette Co., at $25,000.

Kans., Junction City—Leavenworth Brdg. Co., Leavenworth, award. contr. for constr. of rein.-conc. brdg. across Republican River at $45,000.

Minn., Carver—Frankman Bros., Brdg. & Contract'g. Co., 911 Met. Life Bldg., Mpls., award. contr. for construct'g. steel brdg., at $50,000.

Minn., Little Falls—Minneapolis Brdg. Co., 728 Metropolitan Life Bldg., Mpls., award. contr. for Royalton-Mississippi River brdg., at $35,890.

Minn., St. Cloud—Minneapolis Brdg. Co., award. contr. for brdg. across Mississippi River, at $35,000.

Minn., Windom—Joliet Brdg. & Iron Co., award. contr. for construc. of brdg. No. 2773 across Des Moines River—betw. Secs. 35 and 35—at $5,100.

Mo., Moberly—Layne & Bowler, 400 Interstate Bldg., Kans. City, Mo., award. contr. for water wks. and addl. wells., at $30,000.

Mont., Missoula—Lord Constr. Co., Hamilton, award. contr. for new brdg. in Ronan, at $2,380.

Mont., Myers—Security Bridge Co., Billings, award. contr. for construct'g. brdg. 152 ft. steel span, conc. pier, 40 ft. high, at $11,800.

Neb., Lincoln—Martin Constr. Co., local, award. contr. for construc. of conc. brdg., at $7,500.

Neb., N. Platte—Edw. F. Pettis, Lincoln, award. contr. for brdg. across So. Platte River, at $10,000.

Neb., Wakefield—Standard Brdg. Co., 1302 City Natl. Bk. Bldg., Omaha, award. contr. for construct'g. 4 60-ft. brdgs., at $7,946.

N. J., Jersey City—W. T. Crichfield, No. 2 Green St., city, award. contr. for 4420 sq. yds. paving Gates Ave.—asph. on conc.; also 550 sq. yds. Belgian blks. on conc.

N. Y., Brooklyn—Cranford Co., 52 9th St., will probably be award. contr. for paving and repaving rdwy. 54th St., 9th Ave. to Ft. Hamilton Pkway., at $10,327.

N. Y., Rome—W. S. Rae, 439 Oliver Bldg., Pittsburgh, award. contr. for construct'g. plate girder brdg. over Black River Canal on Whitesboro St., at $11,603.

O., Canton—Geo. W. Luke, city, award. contr. for reinforc'g. brdg., Perry Twp., at $3,178.

O., Cincinnati—Wm. F. Nickoson, city, award. contr. for repairing brdg. Muddy Crk. Rd., at $3,708.

O, Troy—Rochester Brdg. Co., Rochester, Ind., award. contr. for brdg. over Stillwater River, at $15,600.

O., Youngstown—N. R. Porterfield, Inc., city, award. contr. for construct. substruc. and superstruc. for rein. conc. through-arch brdg. on Alliance-Salem Rd., at $8,520. 75-ft. span, 24 ft. wide.

Okla, Bartlesville—Rochester Brdg. Co., city, award. contr. for construct'g. 8 brdgs., at $73,284.

Okla., Okla City—Reinhart & Donovan, city, award. contr. for construct. brdg. over by-pass at waterwks., at $5,789.

Okla, Tulsa—Froebe-Gray Constr. Co., Muskogee, award. contr. for construct'g. 13 brdgs., at $11,693. Brdgs. will be built as follows: 5 in Lane Twp.; 6 in Fry Twp., and 2 in Red Fork.

Okla., Watonga—H. E. Livingston, Taloga, Okla., award. contr. for const. of several brdgs., Blaine Co., at $6,635.

Ore., Astoria—Wm. E. and Jno. F. Johnson, award. contr. for clearing and grading Upper Nehalem brdg., at $3,379.

Ore., Salem—Portland Brdg. Co., award. contr. for construct'g. draw brdg. across John Day River, Clatsop Co., at $20,999. Lindstrom & Geighinson, contr. for Goble Crk. Brdg., Columbia Co., at $4,252.

Pa., Butler—W. S. Rae, Pittsburgh, award. contr. for construct'g. Main brdg., at $184,198.

Pa., Greensburg—M. F. Scholl, W. Newton, award. contr. for I and channel-beam incased brdg.—48-ft. span, 16-ft. rein. conc. rdway. over Pollock Run, at $3,175.

Pa., Philadelphia—E. C. Fish, city, award. contr. for reconstruct'g. approach to Penrose Perry brdg., at $15,000.

S. C., Charleston—Austin Bros. Co., Atlanta, Ga., award contr. for construct'g. steel draw brdg. and timber approach across Dawho River, at $28,500.

Tenn., McGhee—Larimer & Burkett Brdg. Co., were sub-let contr. by Fort Loudon Brdg. Co., for construc. of toll brdg. across Little Tenn. River, at Indian Rock.—Steel, on rein.-conc. piers, $18,000.

Wash., Spokane—Heikkila, Miller & Paulson, city, award. contr. for constr. of new trunk sewer. Sherwood Adn., at $2,844.

Wash., Charleston—Warren, Moore & Co., Colonial Trust Bldg., Phila., award. contr. for sewerage sys., at Navy Yd., at $13,887.

W. Va., Wellsburg—B. O. Cresap, Wellsburg, award. contr. (contingent on bond sale), to construct 2 mi. 12, 20 and 24-in. sewers, at $35,000.

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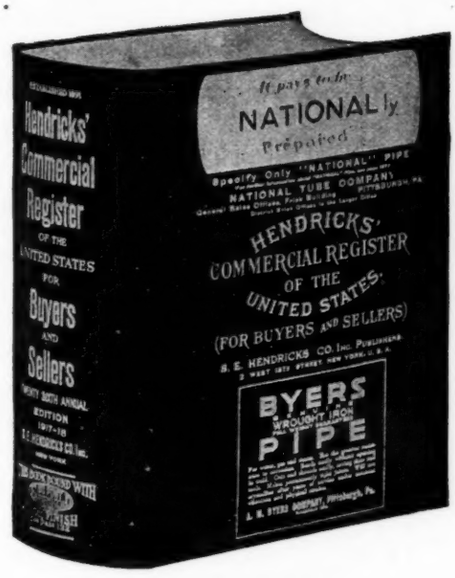
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PROSPECTIVE WORK

ROADS AND STREETS.

Ark., Cotter—35-mile rd. planned by Baxter Co. Commrs., Mtn. Home, Ark. Rd. will run from Cotter to Missouri boundary. Est. cost $163,000. H. R. Carter, State Hwy. Engr.

Ark., Harrison—36 mi. of rd. in Boone Co. will be mecadamized at approx. cost of $150,000.

Ark., Jasper—Plans completed for grading 20-mi. hwy., Newton Co. Approx. cost $44,000.

Ark., Little Rock—Plans under way for gravel rd. Jackson Co. south from Newport to Woodruff Co. line—33 mi., at est. cost $212,000; also for rd. Randolph Co., Pocahontas so. to Lesterville—10 mi. $61,000.

Ark, Little Rock—Plans prepared by State Hwy. Dept., for rd. through Ozark Nat'l Forest—part Harrison-Russellville Sec. Jefferson Hwy., $40,000 and $20,000 respectively. Fed. and State aid.

Ark., Little Rock—City contemplates paving Pike Ave.—18th to 27th Sts.—with concrete. Plans also under way for graded rd., Van Buren Co.—Formosa through Shirley to county line (30 mi.). Est. cost, $63,895.

Ark., Little Rock—State and Fed. aid will be given for construc. of six rds. Total est. cost $137,446. Hugh R. Carter, State Hwy. Engr.

Cal., Bakersfield—Resolution passed for construct'g. Cholame Pass Rd. Kern Co., will contribute $343,148 towards this work.

Cal., Los Angeles—Plans under way for rd. improv. dist. to bld. 74 mi. rd. in Antelope Valley. F. H. Joyner, Co., Rd. Comr. preparing plans.

Cal., San Bernardino—Work will start at once on San Bernardino-to-Yuma and San Bernardino-to-Barstow hwys. 58 miles between Indio and Kane Springs to be paved at cost of $431,000. State will expend $118,666 on construc. of 15-ft. conc. hwy. Summit to Victorville.

Cal., Santa Ana—City contemplates improv'g. N. Parton St.—Hickey St. to 101 ft. south—conc. curb, gutter and crush. rock and oil macad. pavement; also 4th St.—Bristol to Artesia—4 in. conc. base and 1½-in. asph. oil wearing surface.

Cal., Fresno—Supervisors Kings, Monterey and Fresno Cos., and Cal. Hwy. Comm. are planning construc. of 98-mi. rd. betw. Hanford, Kings Co., and San Lucas, Monterey Co. Total est. cost, $1,502,537.

Colo., Conejus—County will bld. rd. over Cumbres Pass—Antonito to Elk Creek. Est. cost about $30,000.

Fla., Ft. Pierce—St. Lucie Co., Fellsmere Dist. has voted $80,000 rd. bonds.

Ill., Peoria—Peoria County has appropriated $77,000 for bldg. 5 miles of conc. roads. W. E. Emery, Co. Hwy. Supt.

Ind., Ft. Wayne—$147,000 to be expended on Lincoln Hwy., in Allen Co; state and county to share cost of construc. Wm. Tonkle, Co. Supt. Hwys.

Ia., Iowa City—Kalona Road (6½-mi.) will be paved by Johnson County. Approximate cost $32,000. Ed Sulek, Co. Aud.

La., New Orleans—An aggregate of $7,835,000 will be spent by various counties in state for road improvement. Vermilion Parish, $600,000; Beauregard Parish, $600,000; Calcasieu Parish, $900,000; Jeff Davis Parish, $500,000; St. Mary and Lafayette Parishes, $400,000 each, etc.

Mich., Cadillac—City contemplates brick and wood blk. paving a number of streets. Est. cost about $60,000. T. V. Stephens, City Engr.

Mich., Charlotte—Petition filed for construc. of 4½-mi. rd. Eaton Rapid-Lansing Rd.—4½ miles on Mt. Hope Rd., Delta Twp., and 2 miles, Hamlin Twp.

Mich., Muskegon—City contemplating paving Lake St., with conc. Approx. cost $59,416. Paul Grimes, City Engr.

Minn., Minneapolis—$300,000 will be expended on improvement of Burlington trail (to be renamed "Mayo Trail").

Mo., Fulton—Plans under way by Calloway Co. Comrs. to bld. 16-mi. Old Trails Hwy. to Montgomery Co. line. Cost about $75,000.

Mo., Jefferson City—Plans being prepared by State Hwy. Comn., for bldg. 7 mi. conc. rd.—Joplin to Miami. Approx. cost $300,000.

Mont., Bozeman—Streets in Dist. No. 154 will be paved with stand. crush. rock, bithu or other hard surf. matl. $24,430 est. cost.

Use Your Influence

Military Roads

Resolution Adopted by Chamber of Commerce of the United States in convention at Atlantic City, September 21, 1917.

WHEREAS, It is essential that all the transportation facilities of the nation should be brought to the highest state of efficiency in order that foodstuffs may be moved most economically from the farm to the market, that manufactured products be moved at the lowest cost from the factory to the consumer, and

WHEREAS, The Public Highways offer a good, prompt and economical means to supplement transportation by rail and water, therefore

BE IT RESOLVED, That the prompt improvement of our Public Highways is important and should be forwarded in every proper way.

Realizing the transportation congestion crisis, this was one of the most important resolutions passed by the Chamber of Commerce of the United States.

Motor trucks are ready at hand; the roads of the nation must be immediately developed and improved.

A Federal Highway Board is urgently needed.

Use Your Influence

Mont., Choteau—Teton & Flathead Counties to co-operate in bldg. Glacier Pk. hwy. across main range; 12 mi. in Teton Co., and 45 mi. in Flathead.

Neb., Lincoln—Paving Dist. No. 400 created by Council; includes "A" St., to Randolph, and Norman Blvd. from "A" to Summer St.

Neb., Omaha—Ordinances passed for improvement of following streets: 42nd, Dewey to Leavenworth—with asph. conc. Class B; Camden Ave.—25th Ave. to 27th St.; 35th St.—Dodge to Cass—asph. conc. Class B. City also contemplates widening 20th St.—Leavenworth to Dodge.

N. J., Newark—Bd. of Freeholders, Essex Co., contemplates following improvments: granite blk. paving on conc. base—Bloomfield Ave.—Montclair-Verona line through Verona, Caldwell, N. Caldwell and W. Caldwell to Dutch lane, at est. cost $300,000; Avondale Rd., Nutley—Wash. Ave. to Avondale Brdg., $21,300; Tuger St., Belleville, Wash. Ave. to Belleville Brdg., at cost $20,300 (bitum. conc.); Stuyvesant Ave., Irvington-Newark line to Union Co.—$95,-200; Gregory Ave., W. Orange-Luddington Rd. to Mt. Pleasant Ave., $75,800, and others.

N. Y., New York—Suffolk Co. has authorized appropriation $200,000 for rds. as follows: Huntington's appropriation, $104,300 for conc. rd. in Wall St., Woodbury Ave., Lincoln Ave., and Depot Rd. and various others. Babylon's appro. $12,150 and Brookhaven, $86,606. Plans also under way for rebldg. main rd. from Nassau Co. line through Cold Springs Harbor, at $20,000.

N. C., Rutherfordton—$11,850 bonds to be voted Jan. 10th by Rutherfordton County, for purpose of construct'g. rds., in Cool Springs, Rutherfordton, Green Hill and Chimney Rock Twps. C. F. Watson, Chrmn. Co. Comrs.

N. D., Forman—Sargent Co. planning to bld. 68 mi. state rds. Est. cost $40,000.

O., Cincinnati—State Hwy. Com. recommends reconstruc. of State Mkt. Rd. No. 6—City to Mt. Washington (50 mi.).

O., Cincinnati—Ords. amounting to $170,-000 have been drawn up, for street and sewer improvements—about 30 streets.

O., Cincinnati—Ord. passed providing for issuance of bonds to amt. of $114,500 for purpose of improv'g. Evanston Ave., Hill Crest Rd., Pike St., and others.

O., Lima—$400,000 bonds voted for street paving. Plans now being prepared by C. V. Miller, Engr.

O., Tiffin—Seneca, Hopewell, Big Spring and Scipio Twps., proposes to bld. 1½-mi. Tiffin-Upper Sandusky Rd.; 2½ mi. Fostoria Rd. and 2-mi. Fostoria-Carey Rd.

Okla., Oklahoma City—City will pave 100,-000 sq. yds. with asphaltic conc. Est. cost $250,000. C. F. Semmelbeck, City Clk.

Pa., Hollidaysburg—Blair County will have available for street work $36,100, which will be used for bldg. sec. of rd. connect'g. Altona and Byrone—about 3 miles.

Pa., Mt. Oliver, Pitttsburgh—Ord. passed to re-establish grade Hays Ave.—Onyx Ave. south to Borough Way; also grade, curb and pave Hays Ave.—Onyx to Quincy.

Pa., Pittsburgh—Plans under way for bldg. 50-ft. rein-conc. boulevard—end of E. Carson St. to McKeesport. Est. cost about $650,000. Ord. also passed for grading, paving and repaving portion of Bigslow Blvd., and So. Side Ave.—Hespen St. to Sunset Ave. E. Swan, City, Engr.

Pa., Pittsburgh—City plans to repave many principal streets, aggregating 1,000,-000 sq. yds. $195,000 est. cost of resurfacing drives in Schenley Pk. and $125,000 in Highland Park. Est. cost of all street work $4,000,000.

Pa., Pittsburgh—Public Wks. Comm. is considering petition for repaving of Smithfield St. with wood blk. Est. cost $50,000.

S. D., Sisseston—Appropriations by Co. Bd. as follows: $5,000 for const. of Co. Rd. No. 6; $2,000 for constr. of Co. Rd. No. 2; $3,500, for constr. of east and west rd. through Norway, Minn and Lien Twps.; $1,000 for constr. of rd. west in Harmon Twp. from Interstate Brdg. to Co. R. No. 7. R. C. Richert, Co. Aud.

Va., Norfolk—Civic League, Norfolk Highlands, contemplates improv'g. rd. Indian River sec. Norfolk Co. Proposed plans call for paving street from Indiana Riv. Blvd., to Indian Riv. Pk.

Wash., Yakima—City Commrs. have ordered improvement of N. First Ave., at approx. cost $100,000. Streets to be hard-surfaced for heavy fruit traffic.

Wis., Appleton—Conc. hwy. 16 ft. wide will be built betw. Fond du Lac and Oshkosh. Est. cost $75,000. Fond du Lac will expend $25,000; balance state aid.

Wis., Juneau—$50,000 available, in addn. to state and national aid for constr. and maintenance of trunk line hwys., in Dodge County.
cost $80,019.

SEWERAGE AND SEWAGE TREATMENT.

Cal., Long Beach—Bids will soon be called for constr. of vit. pipe sewer in 11th St., Poinsetta Ave., Vine St., 10th, 7th, 6th and 4th Sts., and various other sts. and alleys—abt. 61,000 lin. ft. 8, 10, 12 and 14 inch v. pipe.

Cal., Santa Barbara—Bids soon to be asked for on sewer construc. Plans completed for Riensch-Wurl screen sewage treatment plant.

Ct., Bristol—City contemplating septic tank (or Imhoff), new filteration beds and general improvement wk. to sewage disp. plant. Est. cost $100,000. Sperry & Buell, Engrs., Main St.

Conn., Stratford—City planning to install sewerage sys. and sewage disp. plant. $250,000 approx. cost. C. Potts, 30 Church St., N. Y. City, Engr.

Conn., Torrington—Plans being prepared by C. A. Patterson, Engr., for bldg. outfall sewers. Approx. cost about $25,000.

Ill., Bradley—Bids soon to be asked for construc .of sewerage sys. Est. cost $175,-000. Marr-Green Co., Engrs., 17 S. LaSalle St., Chicago.

Ill., Chicago—City contemplating 260 mi. sewers. Est. cost about $1,500,000. J. Ericson, City Engr.

Ill., Granite City—Plans under way for construc. lat. sewers. Approx. cost $120,-000. E. Hall, iCty Engr.

ill., Springfield—City contemplates laying of sewers on: 17th St.—LaSalle to Ash Sts.—Ash St.—16th to 17th—Moffet Ave.—15th St. to E. Grand Ave.

Ind., Evansville—City will construct sewers in following: Orr Ave.—Walnut St. to Lincoln Ave., with branches; in alley betw. Governor and Rowe Sts., west from Princeton state rd. with branches.

Ia., Clarksville—G. H. Bishop, Engr., Independence, has completed plans for constructg. sewer sys. Bids soon to be called for. Est. cost $35,000.

Ia., Marcus—Plans under way for construction of sewer sys. and disposal tank. Est. cost $42,000.

Kans., Pareone—City has been directed by State Bd. of Health to bld. treatment works for sewage. Est. cost about $20,000. C. A. Haskins, Engr.

Ky., Owensboro—Council has approved plans and specifications for construc. of new sewer system. Est. of City Engr. for the two ditches—one on either side of City—$421,715.

Mass., Boston—Sewer construction in following streets approved by Mayor. Atlantic Ave., Roslindale Branch Stony Brk., W. Roxbury, S. Conway St., N. Beacon St., Brighton, Holton St., Brighton, Rutherford Ave., Charlestown, Hyde Pk. Ave., Hyde Park, and many others.

Mass., Fitchburg—Sewer construc., to amt. of $23,000 planned by City.

Mich., Grand Rapids—City plans sale of $55,000 bonds to bldg. sewers in Pearl, Sheldon, Fairbanks and Canton Sts., Sinclair Ave., and Silver Crk. sewerage system. G. J. Wagner, City Engr.

Minn., Winnebago—C. H. Currie, Engr., Webster, Pa., preparing plans for about 30 blks. sewerage sys. Est. cost $60,000. H. G. Silverson, Village Clk.

Mo., St. Louis—City planning to improve sewerage sys., including 3 serv. drains, Dist. No. 40—3rd St. north to Haeberie Gardens; Dist. No. 141, beginning at 9th and Court Sts., west on Court to 8th, south on 8th to new storage sewer; also sewer west to 7th Sts. C. P. Hoff, City Engr.

Mo., Springfield—City contemplates extendg. sewers and improving septic tanks. Est. cost $35,000. O. D. Chrisman, City Engr.

Neb., Omaha—City plans construc. of storm sewers on 25th and Dahlman Blvd., and sewer and storm water main drain near Carter Lake. Est. cost $59,000. T. J. O'Connor, City Clk.

Neb., Omaha—$175,000 will be expended on sewer construc. in near future by City. J. A. Bruce, City Engr.

N. J., Bonton—C. Potts, 30 Church St., New York City, preparing plans for sewage disposal plant.

N. J., Rahway—City will build, operate and maintain trunk sewer and disposal plant in conjunction with following boros: Garwood, Roselle Pk., Komilworth, Craford, Westfield, Springfield, Union, and S. Grange. Trunk sewer will be built along Rahway River from S. Grange Twp. to tide-water at Rahway. C. H. Lambert, City Clk.

N. J., Trenton—Plans under way for installing sewerage sys. in Riverside Park. Approx. cost about $19,732.

N. Mex., E. Las Vegas—Plans under way for installg. sewerage sys. Est. cost $29,-748. V. K. Jones, City Engr.

N. Y., Brooklyn—Sewer construc. in following streets authorized by Board of Estimate: Van Wyck Ave.—Silkworth Ave. to Jamaica; Jamaica Ave.—Van Wyck to Ellsworth, Metropolitan Ave.—Van Wyck to Troy Ave.

N. Y., Brooklyn—Plans under way for construc. of sewers in N. Railroad Ave., S. Railroad Ave., Alburtis Ave., Way Ave., —about 4,600 ft. Est. cost $26,800.

N. Y., Brooklyn—Sewers will be built in Ave. M., E. 3rd, E. 4th and 60th Sts., Ocean Pkway., and 23rd Ave. Est. cost $44,000.

N. Y., Long Island City—Plans under way for sewer contsruc. in Grand St., Newtown. Cost $20,500.

O., Cincinnati—$54,000 bonds to be issued by City for purpose of bldg. sewers on California Ave., Reading Rd., Bank St. and other streets and aves.

Two Letters from the Same Concern

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O., Cleveland—$3,000,000 bond issue voted for sewer construction.

O., Lima—Bond issue of $155,000 voted for construc. of relief sewers.

O., Mansfield—Ordinance passed for constructing 8-in. san. sewer and appurtenances in Diamond St.—Fair St. to corp. line; Ford St.—Altamont Ave. to Diamond. W. W. Carter, Clk. City Council.

O., Newport—City planning to bld. trunk sewer in York St. from Ohio River to 8th St. Est. cost $15,000. J. Herman, Comr. Pub. Wks.

O., Niles—Plans are being made for construc. of a trunk sewer leading to proposed disposal plant. $16,000 appropriation to be requested.

O., Painesville—Sewer will be built in Sanford St., at approx. cost of $29,000.

O., Toledo—Plans under way for constr. of 1st unit complete intercept. sewer and disp. sys. Est. cost $700,000. H. C. McCline, 229 Valentine Bldg., Engr.

O., Youngstown—Ords. passed for sewer construc. in Shady Run Dist. Bonds to amt. of $19,955 to be issued for this work.

Okla., Okla City—Sewers in 5 Distrs. and san. sewers in 1st Dist. planned by City. Est. cost about $50,000. B. M. Hart, City Engr.

Okla, Tulsa—New bids will be asked for construc. of storm sewer Trenton St.—3rd to Katy. H. H. Wyss, City Clk.

Pa., Elwood City—R. W. Pratt, Engr., 703 Hippodrome Bldg., Cleveland, preparing plans for stall. of trunk sewers and sewage disp. plant. Approx cost $116,000.

Pa., Erie—Street Director, W. D. Kinney, has petitioned Council to appropriate $70,000 for continuation of Myrtle St. storm sewer—8th to 12th Sts.; also for bldg. various other storm sewers in city.

Pa., Johnstown—Plans being prepared by Gannett, Seelye & Fleming, Engrs., 204 Locust St., Harrisburg, for san. sewerage sys. $500,000 bonds voted for this work.

Pa., Morristown—City contemplating extension of sewers. Approx. cost $15,000.

Pa., Parnassus—Plans prepared by State Health Dept., Harrisburg, for bldg. san. sewage sys., interceptg. sewers, sewerage pump. sta. and sewage treatment plant.

Pa., Philadelphia—Laurel Council has passed ord. providing for $60,000 bond issue for purpose of installg. sewer system .

Pa., Philadelphia—Plans are being approved by State Dept. of Health, Harrisburg, for portion of Frankford Creek high level interceptg. sewer.

Pa., W. Chester—State Hwy. Dept. approving plans for northwestern distr. san. sewers and sludge bed, which will be installed at Taylor Run sewage treatment works.

WATER SUPPLY AND PURIFICATION.

Cal., Santa Barbara—Property owners Upper Montecito valley have subscribed $12,000 for bldg. reservoir.

Cal., Vallejo—Plans being prepared by F. H. Tibbets, Engr. Alaska Commer. Bldg., San Francisco, for bldg. reservoir—273,000,-000-gal. cap.—to supply water to Green Valley. Approx. cost $200,000.

Ill., Chicago—City plans following improvements: cast iron water supply pipe, special castings, c. i. fire hydrants, c. i. valves and brick basins to be constructed and laid in—N. Carolina Ave., S. Carpenter St., N. Maplewood Ave., S. Winchester, Wesley and various other streets.

Ill., Quincy—City contemplates 2 mi. water mains—6 to 16-in.; also 1 motor driven triplex power pump, 700 gals. per m., 1 motor driven centrif. pump, 700 gal. per m., elevat. tank, 300,000 gal. on tower, 100 ft. high. W. R. Gelston, Supt. of Waterwks.

Kans., Chanute—City plans improvement of waterwks., including elevated tower—250,000 gal. capacity. Est. cost $42,000. C. Pratt, City Engr.

la., Bossier City—Plans being prepared by Honaker & Swope, Shreveport, for waste water sys., including 4 and 8 inch pipe, 1 elec. and 1 oil pipe. 50,000 gal. reservoir and 1 well. Approx. cost about $30,000.

Mo., Kans. City—Plans under way for water pump'g. sta., in E. Bottoms—20,000,-000-gal. cap. City also contemplates lay'g. 48-in. water main, 22,000 ft. long on Nichelson and Monroe Sts. Approx. cost $500,000. Curtis Hill, City Engr.

Mo., Maysville—City planning construc. of reservoir with 1,000,000-gals. cap. A. D. Hewitt, City Clerk.

Mont., Billings—Resolution passed by Yellowstone Co. Comrs. for appropriation of $11,320 for install'g. water sys. in Claxton's Heights. Connec. will be made with City's water system.

N. C., Benson—City plans constr. of waterwks. sws., involving 4 mi. 6 to 10-in. pipe, 100,000 gal. conc. reservoir, 1 or more deep wells. Est. cost $30,000 to $40,000. Gilbert C. White, Durham, N. C., Engr.

O., Hamilton—Ord. passed for improv. of waterworks and distributing sys., by construct. of new walls, new suction line and other necessary improvements. $18,000 appropriated for this purpose. Karl E. Krieger, Clk. Council.

Okla., Madill—$65,000 will be expended by City to extend water plant (daily cap. 500,000 gals.); erect pumping plant, conc. receiving basin, steel tower and tank.

Tex., Ft. Worth—Plans under way for enlargement of water filtration plant, addn. rapid filters, new settling basins, mixing chamber, chem. house and aeration. John H. Gregory, Conslt. Engr., 170 Bwy., N. Y. City.

Tex., San Angelo—San Angelo Water, Light & Power Co., planning to bld. conc. dam for water from spring of So. Concho River, Dove and Spring Crks. 225 ft. long, 15 ft. high. Est. cost $12,500.

Utah, Brigham City—City will rebuild waterworks with 16,000 ft. of mains.

Wis., Hartford—Plans being prepared by A. Martin, Engr., for bldg. pump house and reservoir. Approx. cost about $20,000. Council has also authorized St. Commr. to order 200 ft. 4-in. water mains. Wm. Radke, City Clk.

BRIDGES AND BUILDINGS.

Wash., Seattle—Sam Humes, Co., Engr. has completed plans for install'g. 3,500 ft. 12-in. wood stave pipe; also c. i. pipe, for exten. of water works to serve King Co. Indust. sites on Duwamish River.

Ariz., Tucson—T. Haddock, State Engr., Phoenix, preparing plans for bldg. brdgs. over Santa Cruz and Sahuaritz Rivers.

Ariz., Little Rock—Bids soon to be asked for construct'g. bridge, 40-ft. wide, rein.-conc. arched constr. Approx. cost $800,000. D. B. Luten, Engr., Indianapolis, Ind.

Cal., Eureka—Plans completed for constr. of steel suspension brdg. across Eel River at Alderpoint. Structure will cost about $45,000.

Cal., Los Angeles—Bd. of Supvrs., Los Angeles Co. have passed resolutions authorizing constr. of Anaheim-Telegraph brdg. over San Gabriel River, at Temple-Mission Brdg. over Rio Hondo, by force account. Pile and timber con.

Ky., Paducah—City planning to construct rein.-conc. bridge over Island Crk., on Bridge St. Approx. cost $17,000. L. A. Washington, Comr. Pub. Works.

Minn., Mazeppa—Plans being prepared for rein.-conc. steel brdg. Same will be 30 ft. long and 54-in. high. Est. cost $40,000. A. F. Wright, City Clk.

Minn., Minneapolis—Petition has been filed to bld. viaduct—approx. half mile long—to connect Prospect Park with East Side industrial sec.

Mo., Kans. City—City will bld. viaduct 1,800 ft. long. Approx. cost $700,000.

Mont., Great Falls—State Hwy. Dept. has prepared plans for 2 conc. brdgs. Cascade Co. Est. cost $537,000.

Neb., Brady—Plans under way for construc. of 5 state aid brdgs. across Platte River. $30,000 bonds to be voted (half est. cost) for this purpose. Concrete will be used.

N. Y., Brooklyn.—Plans for brdg. over Sheepshead Bay at Emmons Ave. and Ocean Ave. to Manhattan Beach, are being made by City.

N. Y., Cohoes—W. Warden, Engr., 24 James St., Albany, preparing plans for brdg. betw. here and Lansingburg. Est. cost about $57,000.

N. Y., Rochester—Bids soon to be called for by Frank X. Pifer, Clk. Bd. of Contr., for construc. of brdg. over river at Clarissa St. Est. cost $300,000.

O., Columbus—Conc. brdg. will be built across Olentangy River. This is part of new sys. of driveways and walks throughout campus State Univeersity. Jos. N. Bradford, University Archt.

Okla., Dixie—$50,000 will be expended for brdg. over Canadian River at Newcastle.

Ore., Coquille—City contemplating brdg. across Coquille River. Cost $30,000.

Ore., Hood River—Appropriation of $8,000 made by Co. Court toward constr. of Columbia River Hwy. brdg. across Hood River. Structure will be of orn conc. and cost about $30,000.

Wash, Tacoma—Steel brdg. to be built over Hylebos waterway on S. 11th St. $75,000 approx. cost.

W. Va., Wheeling—City and W. Va. Traction & Elec. Co., Wheeling, planning to bld. 2 rein. conc. brdgs. over Wheeling Crk. Est. cost $70,000.

Wis., Mauston—City plans to constr. brdg. over Wisconsin River betw. Juneau and Adams Cos.—5 112-ft. steel spans with 18-ft. rdway. J. T. Patterson Co., Engr.

Wis., Milwaukee—Bids soon to be called steel. $9,000 also appropriated for conc. for on repair'g. Holton St. viaduct. 2½ tons brdg. over Kinnickinnic River at Cleveland Ave.

Howard E. Coffin, of The Council for National Defense, says:

"We have hysterical demands for economy in every line. Some municipalities are stopping road building and other public work. Waste is bad, but indiscriminating economy is worse." *The Chicago Tribune* says: "Paris has not suspended public building operations because of the war. Neither has Berlin. Let there be no havoc in the building trade. To put a ban on legitimate public building projects is to sow disorder and unrest."

We need roads to mobilize the potential resources of America—let us keep building them—and meet the higher costs by better handling of men and cost-saving efficiency in machinery.

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LITTLEFORD BROS., 460 E. Pearl St., Cincinnati, Ohio.

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The success of a sale of state, county or municipal bonds depends entirely upon the publicity given it.

The majority of all municipal issues do not reach the investor directly, but pass through the hands of a dealer who specializes in their purchase and sale.

There are several hundred municipal bond dealers located throughout the country. Many of these bond firms buy a great variety of issues from counties, cities and villages located in the East and West, North and South.

Since a really successful sale will only result from competitive bidding participated in by many different bidders, it is clear that a municipality should advertise its bond offering in a paper specializing in bond news and read by all the dealers interested in this news.

The Bond Buyer, issued daily and weekly, is just such a medium! It never speaks of anything but municipal bonds, and, after twenty-five years of this specilization, it has come to be accepted by legislators and public officials as **"The Authority on Municipal Bonds."**

There is a service rendered by **The Bond Buyer** that every county, city and town treasurer should know about. **If you have bonds to sell,** address

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RATES:

Want Ads. 1½ cents per word.
For Sale Ads. 25 cents per line.
Proposal Ads. 15 cents per line.
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Engineering Publishing Co.
INDIANAPOLIS, IND.

Bids received until January 2, 1918.

PORTS OF TOLEDO AND NEWPORT IMPROVING YAQUINA BAR AND HARBOR, OREGON.

Office of the Joint Secretary Ports of Toledo and Newport.

Toledo, Oregon, Nov. 13, 1917.

Sealed proposals will be received here at this office until 10 o'clock a. m., January 2, 1918, and opened at Newport, Oregon, at the hour of 2 o'clock p. m. on same day for the furnishing of stone and the construction of South Jetty at entrance to Yaquina Bay, Oregon.

Further information on application.

LEE WADE,
Secretary for Joint Ports.

Bids received until January 5, 1918.

LEVEE CONSTRUCTION.

Chamois, Mo.

Sealed proposals will be received up to 1 o'clock, January 5, 1918 ,at the office of the Secretary of the Board of Commissioners of the Shawnee Creek Drainage District in Chamois, Missouri, for the construction of 60,000 cubic yards of earth levee.

Plans, specifications, bidder's forms, amount of bidder's check, bond and all information needed for bidders can be had of the Engineer, H. E. Steinmann, Chamois, Mo.

Legal advertisement in the News of Osage County, Chamois, Mo.

J. RICHARD GARSTANG,
Secretary, Chamois, Mo.

H. E. STEIBMANN,
Engineer, Chamois, Mo.

Bids received until January 7, 1918.

STATE OF CALIFORNIA, DEPARTMENT OF ENGINEERING. CALIFORNIA HIGHWAY COMMISSION.

December 10, 1917.

NOTICE TO CONTRACTORS.

Sealed proposals will be received at the office of the California Highway Commission, 515 Forum Building, Sacramento, Cal., until 2 o'clock p. m. on January 7, 1918, at which time they will be publicly opened and read for construction in accordance with the specifications therefor, to which special reference is made, portions of State highway as follows:

San Diego County, between a point 3 miles east of the Willows and Sweetwater River (VII-S. D-12-D) about 3.7 miles in length, to be graded.

Plans may be seen, and forms of proposals, bonds, contracts, and specifications may be obtained, at the said office, and they may be seen at the office of the Division Engineers at Los Angeles and San Francisco, and at the office of the Division Engineer of the division in which the work is situated. The Division Engineer's offices are located at Willits, Dunsmuir, Sacramento, San Francisco, San Luis Obispo, Fresno, and Los Angeles.

No bid will be received unless it is made on a blank form furnished by the Commission. The special attention of prospective bidders is called to the "Notice to Contractors" annexed to the blank form of proposal, for full directions as to bidding, quantities of work to be done, etc.

The Department of Engineering reserves the right to reject any or all bids or to accept the bid deemed for the best interests of the State.

NEWELL D. DARLINGTON,
CHARLES F. STERN,
HENRY J.WIDEMANN,
California Highway Commission.
GEORGE R. WINSLOW,
First Asst. Highway Engineere.
WILSON R. ELLIS,
Secretary.

Bids received until January 8, 1918.

NOTICE OF PUBLIC LETTING.

Notice is hereby given that the Board of Commissioners of Adams County, Indiana, will receive bids for the construction of a macadamized road in Root Township, in said county, known as the Kukelhan, macadam road, up and until 10 o'clock a. m., on Tuesday, January 8, 1918, at the regular meeting of said board of commissioners, held in the City of Decatur, Adams County, Indiana, sealed bids will be received for the construction of said road in accordance with the plans, specifications and report of the viewers and engineer, which are now on file in the Auditor's office of said county, said road to be built of crushed stone alone.

A bond must accompany each bid in twice the amount of the bid filed, conditioned for the faithful performance of said work, and that the bidder, if awarded the contract, will enter into contract therefor and complete the same according to such contract and in acordance with the bid filed.

All bids shall be made so as to give the amount for which said road will be constructed for cash, payable on estimates to be made by the engineer in charge, not to exceed eighty per cent. of any one estimate, out of the funds to be hereinafter raised by the sale of bonds as required by law.

The Board of Commissioners reserves the right to reject any and all bids.

JOHN MOSURE,
Auditor, Adams County, Ind.

(At same time and place bids will be received, subject to same conditions, for construction of the Roop-Wagner macadam road in Blue Creek Township; the Fred Thieme macadam road in Union Township; and the Ehlerding macadam road in Preble Township.—Editor.)

Bids received until January 9, 1918.

NOTICE TO ROAD CONTRACTORS.

Notice is hereby given that the Board of Commissioners of Tippecanoe County, State of Indiana, at the County Auditor's office in the City of Lafayette, Indiana, on the 9th day of January, 1918.

2.83 miles of brick road improvement known as the W. A. Dresser et al road.

2.39 miles of brick road improvement known as the A. F. Werkhoff et al. road, as ordered by said board to be constructed, and at said time will let to the lowest responsible bidder, to contract for the construction according to plans, specifications, profile, estimate, etc., now on file in the office of the County Auditor of said county at Lafayette, Indiana.

Bidders will be required to file with their bids, bonds for double the amount of said bids, conditioned according to law, at least one of which sureties on such bond must be a resident of said county or a surety company doing business in the county, and affidavits denying collusion, as the law provides.

The right to reject any and all bids is reserved by the board.

GEO. W. BAXTER,
Auditor.

The Government Must Have At Once Skilled Workers in the AVIATION SECTION of the Signal Corps

For the further extension of the aviation branch of the United States Navy, Secretary Daniels has authorized the enlistment of 8,000 young men and in doing so has opened up most attractive opportunities in this new and unusually appealing service. There is an important and immediate need for mechanicians for Naval aviation for the ratings of machinists' mates, carpenters' mates, quartermasters, coppersmiths and blacksmiths. These men will not be enlisted for pilot's duties but coming into the service with a general mechanical turn and a liking for the work they will receive a special and unusual training for the building, handling, repairing and overhauling of the Navy's air craft. Succeeding in this they will be used as the ground personnel of the flying corps.

Bids received until January 15, 1918.

POWER DAMS.

Calgary, Can.

The Alberta Hydro-Electric Company, Limited, with head office at Calgary, Canada, as determined by its Dominion Charter, has been offered a City of Calgary Power Contract, and will receive tenders until the 15th day of January, 1918, for the construction of a series of Power Dams, along the Bow River, through and about suburbs of the City of Calgary; the construction of the said dam to start immediately after the signing of the contract, and the approval of its constructional details by the Government; the loss being incurred through the operation of steam plant renders this imperative.

Plans, Sections, etc., may be seen at the Company's office, Dominion Bank Building, Calgary, Canada.

The bidders may have to accept the Company's Bonds in payment or part payment of the work done.

Apply to

ZEPH. MALHIOT,
Consulting Engineer.
Box 1480, Calgary.

Bids received until January 4, 1918.

GREATER WINNIPEG WATER DISTRICT TENDERS.

Winnipeg, Manitoba, Canada.
October 30, 1917.

On order of the commissioners of the Greater Winnipeg Water District, the date for receiving tenders on the following contracts has been extended to noon on Friday, January 4, 1918.

Sealed tenders will be received by the Commissioners of the Greater Winnipeg Water District up to noon on Monday, January 4, 1918, for each of the following contracts:

Contract 65: Construction of a Pressure Pipe Line from Red River to McPhillips Street Reservoir.

Deposit of $20.00 required.

Contract 69: Manufacture and supply of 48-inch pre-moulded Reinforced Concrete Pressure Pipe.

Deposit of $10.00 required.

Contract 68: Supply of Cast Iron Pipe and Specials.

Deposit of $10.00 required.

Specifications and form of tender may be obtained on application at the office of the District on and after November 7th, accompanied by a certified check for the amount of the deposit, which deposit will be returned on submission of tender or return of documents.

R. D. WAUGH,
Chairman of Commissioners.
501 Tribune Building, Winnipeg, Man.

PROPOSED ROADS AND BRIDGES.

Santo Domingo City,
Dominican Republic, West Indies.

The United States Military Government in Santo Domingo, Dominican Republic, contemplates spending the sum of about $1,500,000 for the construction of improved roads and bridges within the next two years.

Proposals will probably be invited on about one-half of this work within the next sixty (60) days, and official detail announcement of the work will be made at that time.

Any contractors or engineers desiring detailed information with regard to this work should address A. J. Collett, Director General of Public Works, Santo Domingo City, Dominican Republic, West Indies.

MISCELLANEOUS WANTS

WANTED—Salesmen familiar with the contracting trade to sell our line of asphalt surface heaters, tool furnaces, blow torches, etc., on a commission basis in conjunction with their non-competitive lines. Some western and southern territory now open. Address "Asphalt," care of Municipal Engineering, 538 S. Clark St., Chicago, Ill.

WANTED—A live salesman in every state of the Union to carry an excellent sideline, on a commission basis. New device for testing sand. Fits the pocket. Recommended by prominent Engineers and Contractors. Popular in price. Liberal commission. Address "Sand Tester," care Municipal Engineering, 538 S. Clark St., Chicago, Ill.

WANTED—First class, reliable contracting salesmen in states of New Jersey, Ohio, Michigan, California and Missouri, to sell our line of Contractors Locomotives, portable track and hauling cars on a liberal commission basis. Address "Locomotives," care of Municipal Engineering, 538 S. Clark St., Chicago, Ill.

WANTED—First class salesmen who have had successful experience in the selling of large concrete mixers for big bridge, building, dock and subway construction to sell our line of concrete mixers on a commission basis. The concrete is forced via pneumatic pressure through pipe line to forms at any distance. No more need for expensive and complicated overhead chuting systems—entire new process, and already successfully used on some of the largest construction jobs in the country. Address "Pneumatic," care Municipal Engineering, 538 S. Clark St., Chicago, Ill.

WANTED—Commission salesmen to handle our line of engineering instruments as a side line. Will furnish salesmen with a photograph album and complete particulars. Samples will be submitted for inspection to well rated prospects. Address "Instruments," care of Municipal Engineering, 538 S. Clark St., Chicago.

WANTED—Contracting salesmen to introduce our Ford attachment to contractors. This attachment can be fitted to ordinary Ford chassis by any ordinary garage man. Liberal commission proposition for the right men. All territories now open—prompt deliveries guaranteed. Address "Ford," care of Municipal Engineering, 538 S. Clark St., Chicago, Ill.

WANTED—Salesmen who have been selling heavy duty trucks to contractors and who have failed to secure prompt deliveries to represent our line of 3½ to 5-ton, on a commission basis. Immediate deliveries guaranteed. Address "Truck," care of Municipal Engineering, 538 S. Clark St., Chicago.

WANTED—Well established and successful salesmen having experience in selling contractors to take agency for our line of contractors' locomotives which operate on crude oil, fuel oil, or low grade distillate. Locomotives operated by one man and stick to the track. Address "Fuel Oil," care of Municipal Engineering, 538 S. Clark St., Chicago, Ill.

WANTED—Salesmen to sell our pneumatic pressure cylinder scarifier on a commission basis. This attachment can be attached to most any road roller and is positive in its action. Address "Pressure," care of Municipal Engineering, 538 S. Clark St., Chicago, Ill.

WANTED—Salesmen experienced in selling the contract trade, to sell a line of 1-ton trucks on a commission basis to contractors for the haulage of light materials, tools, etc. Will carry 2-ton load. Some valuable territory.

A4, Municipal Engineering, 538 S. Clark St., Chicago.

Experienced Motor Truck Sales Manager

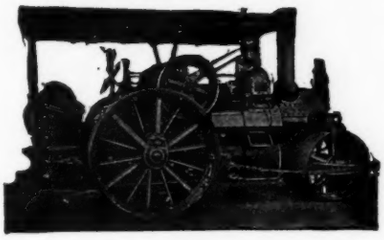
Is in position to consider proposition from Motor Truck manufacturer in a position to make prompt deliveries of 5-ton trucks to contractors. Have been connected with one of five largest truck manufacturers for six years. References furnished. Address A 1120, care Municipal Engineering, 538 S. Clark St., Chicago.

Few Open Territories

LEADING Manufacturers of 3½ and 5-ton Motor Dump Trucks, in position to guarantee immediate delivery, will give entire factory discount to best contracting salesmen in few open territories with understanding that one-half of their discount be given to reliable Motor Dealer (for service) in each city in which trucks are sold. Proposition will interest you.

Address A1126, care Municipal Engineering,
538 S. Clark Street, Chicago.

IROQUOIS ROLLERS TANDEM MACADAM



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The pipe that WON THE TEST for crushing strength before the Louisville Sewer Commission, showing an average CRUSHING STRENGTH OF 43 PER CENT HIGHER than competitors' samples. Just a little better than the rest. Write us today for particulars.

CANNELTON SEWER PIPE CO. . . Cannelton, Ind.

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Pivot Lock Manhole Covers

Will not prevent explosions but it will have to be ***some*** explosion to blow the cover skywards! The cover would simply lift and allow the gases to escape. They Positively **lock** when seated and they are "Locked To Stay"—they **cannot** be unlocked by any unauthorized person.

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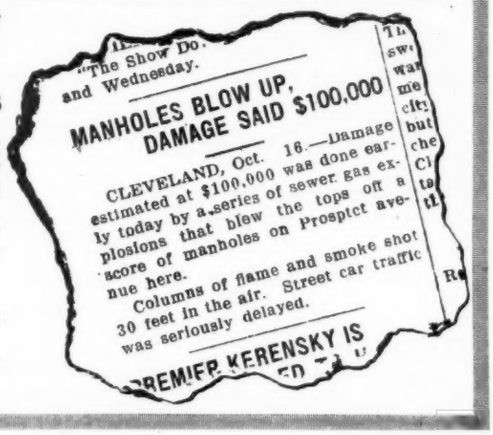
Makers of Merriman Steam Melting Asphalt Plants.


"The Show Do.
and Wednesday.

MANHOLES BLOW UP, DAMAGE SAID $100,000

CLEVELAND, Oct. 16.—Damage estimated at $100,000 was done early today by a series of sewer gas explosions that blew the tops off a score of manholes on Prospect avenue here.

Columns of flame and smoke shot 30 feet in the air. Street car traffic was seriously delayed.

PREMIER KERENSKY IS

Holzbog Sanitary Garbage Carts are smell-tight and can't leak.

Send for Catalog if Interested.

GEO. H. HOLZBOG & BRO.
Manufacturers of Sanitary Carts, Ambulances and Litters
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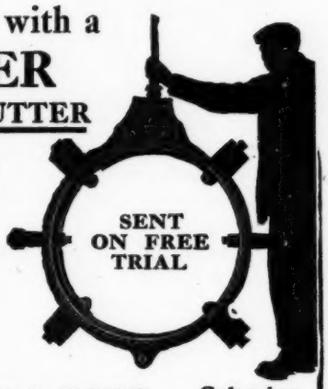
RATCHET PIPE CUTTER



You will be surprised at the speed. At the Smooth, Clean, Square Cut. No filing or reaming after the Automatic Strickler has done its work. As smooth on 30" pipe as on ⅜". Each size cuts a range of pipe sizes.

Just tell us the size of Pipe you are going to cut. No obligation on your part.

W. W. STRICKLER & BROS., Columbus, Ohio.

STEWART SEWER CLEANING MACHINE

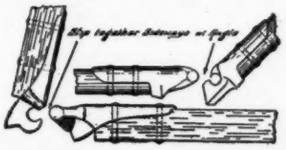
Water Cleaning System if you wish it, or Drag Bucket type.

Also have TURBINE SEWER CLEANING MACHINE at Low Price.

WE WILL PAY FREIGHT AND CHARGE TO BILL.

We Ship Rods for Trial—who else will do this?

We also make a Rod that will float. Also Rods with wheels for conduit work.



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No Deep Shoulder Cut for Couplings—Rods retain full size and strength

Investigate our JUMBO ROD

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THEREFORE NO DUTY FOR PURCHASER TO PAY
PACIFIC COAST DELIVERIES MADE FROM SAN FRANCISCO.

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GUARANTEED NOT TO RATTLE OR DISH

Full Line of MANHOLE and CATCH BASIN COVERS of all Kinds.

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Manholes, Catch Basins, Inlet Basins, Park Basins (All Styles)

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Give widest possible publicity to your Proposal Advertising. Your advertisement in *Municipal Engineering* will carry your message to leading and well-rated contractors specializing in the construction of Streets, Roads, Sewers, Bridges, Water Works Extension, Etc.

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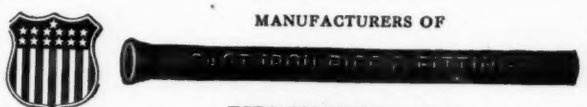
American Cast Iron Pipe Company

MANUFACTURERS OF



BIRMINGHAM, ALA.

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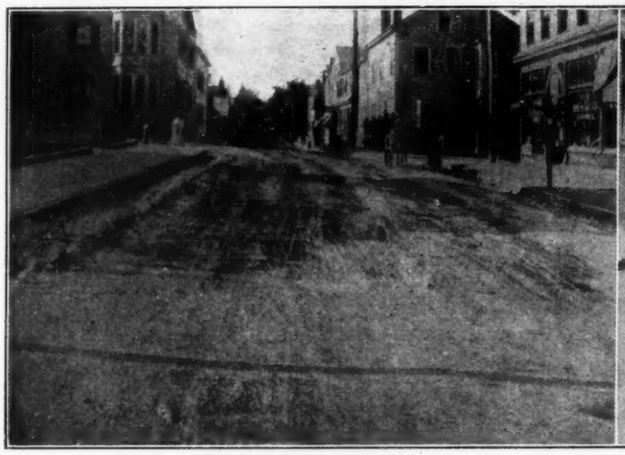
"KEEP THE HOME FIRES BURNING"

Save and spend wisely—thrift or luxury in excess may become a National weakness—for never in the Nation's History was it so vital to have Good Roads for transportation.

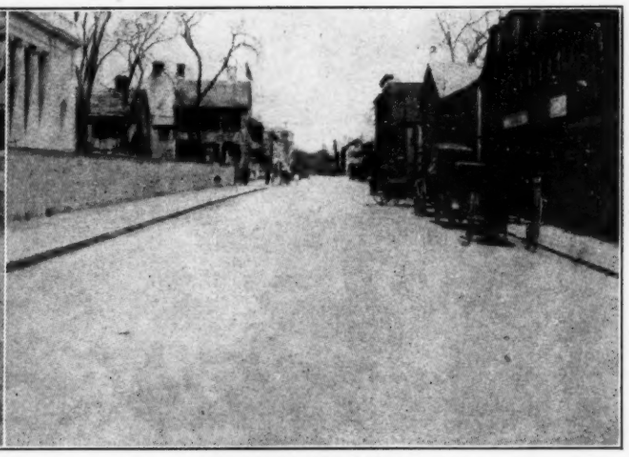
It is necessary to Keep up Public Improvement—it would be false economy not to.

Have your streets paved with a substantial construction that will stand the motor vehicle traffic.

Pave with BITULITHIC



NEW BEDFORD, MASS.
Pleasant Street, showing old Macadam before paving with Bitulithic.



NEW BEDFORD, MASS.
Pleasant Street after paving. Bitulithic surface laid over old Macadam.

"Over the Top" of old macadam and old pavement surfaces (which are too far worn to be of further value as a pavement surface but still of value as foundation for a new surface), **thus saving the expense of new concrete base.**

BITULITHIC

is the city's best asset—Pave the right way—it is the only method that pays.

Keep your streets well paved—

Insist on BITULITHIC

Help "win the war" by affording good streets for motor transportation.

All to gain—Nothing to Lose.

STOP — THINK — ACT.

Investigate BITULITHIC—It is the pavement worth while.

Write for Illustrated Booklets.

Warren Brothers Company

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Main Street, Lewisburg, Pa. Brick pavement filled with Barrett's Paving Pitch.

Barrett's PAVING PITCH

Where Every Joint is an Expansion-Joint

THE joints of this pavement are filled with Barrett's Paving Pitch.

When the bricks contract in cold weather the pitch sinks a little lower in the joints, but never lets go of the bricks nor permits any crack or break in its waterproof seal.

That guarantees the foundation from frost or washout.

When the bricks expand on a hot day there is no pressure against curbs or manholes or street-car rails, for the pitch surrounding each brick is merely squeezed a little and rises slightly in the joints.

If some outside agency, such as settlement over a cut in the pavement not properly restored, cracks the waterproof seal, the pitch unites and presently closes the gap automatically.

Pitch will last as long as the brick. It is impervious to the attack of water or weather or automobile-drippings.

When, after twenty or thirty years, the bricks are finally worn out and taken up to be replaced, the pitch will still be found clinging snugly to the brick.

Good municipal engineering demands that every joint be an expansion-joint. Curbs out of line, cracks, breaks and blow-outs, and troublesome expansion-joints are not unforeseeable misfortunes, but are the inevitable results of an attempt to ignore nature's laws.

The standard pitch for paving is Barrett's Paving Pitch.

Look for the label on the barrels.

Booklets free on request. Address our nearest office.

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